Anderson & Lord

Effect of Impact On Highway Bridges

Civil Engineering

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EFFECT OF IMPACT ON HIGHWAY BRIDGES

BY

HAROLD BROTHER ANDERSON
AND
WALTER EUGENE LORD

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

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June 1, 1910

This is to certify that the thesis of HAROLD BROTHER ANDERSON and WALTER EUGENE LORD entitled Effect of Impact on Highway Bridges is approved by me as meeting this part of the requirements for the degree of Bachelor of Science in Civil Engineering.

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EFFECT OF IMPACT ON HIGHWAY BRIDGES.

I. INTRODUCTION.

Until instruments were invented for measuring, at least approximately, the stresses produced by loads moving over a bridge, an exact investigation of impact in steel bridges was practically an impossibility. When several such instruments were devised, about 1895, great impetus was given to the study of this phase of stress produced in steel bridges.

As a result of several tests made with various instruments, many empirical formulae for impact have been developed. Of these the most commonly accepted is that devised by Schneider, in which the amount of impact is expressed in terms of the maximum live load stress and the length of span loaded to produce that stress. This formula, $I = S(300/300+L)$, and other formulae presented by the first investigators, have all proven to be too extravagant on account of the fact that they allow for too large a factor of safety.

The most recent and complete study that has been made of this subject was that carried on under the direction of Professor F. E. Turneaure of Wisconsin University with the aid of instruments designed by himself. These tests were made in the interest of the Maintenance of Way Association, who furnished him with all facilities for carrying on his experiments. After a series of tests covering a period of three years, the following formula was reported to the subcommittee on Impact Tests at the meeting of the Maintenance of Way Association, in April, 1910.

Percentage of Impact $I = \frac{100}{(1 + L^2/20,000)}$,

where L is the span in feet. The adoption of this formula is now under discussion.

These formulae, in general, apply to steel bridges for railways, and it can be readily understood that the impact in highway bridges may differ radically from the value as determined by any of these formulae, since the kind of loading is entirely different.

The object of this thesis is to verify, if possible, the accuracy of the above formulae, or to deduce a new formula applicable to highway bridges. In order to accomplish this, tests were made on several bridges of varying span and floor systems, the instruments used being those designed by Turneaure.

II. THEORY OF IMPACT.

In order to present the discussion of impact, it may be well to distinguish between loads as regards to their method of application. Loads which are at rest upon a beam or a bar, or those which increase from 0 up to the final value, P, in such a way that the deformations at different instants are proportional to the loads acting at those instants, are called static loads. Loads applied suddenly, or loads which are already in motion before they are applied, are called dynamic loads.

The effect of a suddenly applied load is much greater than that caused by a static load. In this discussion impact will be taken to mean the excess of stress or deformation above that produced by the static load. This phenomenon can be best illustrated by means of a weight suspended from a spring, first gently lowering the weight, and next raising it and dropping it suddenly. In the latter case, the maximum elongation attained will be about twice as much as in the first case; but after a series of oscillations have occurred, the weight will come to rest with the same elongation as for the static load.

The theory of impact on bars and on beams is quite definite, as its derivation has been proven beyond doubt by numerous experiments. If we let P in Fig. 1, represent a tensile load applied to a bar by increments, so that the elongation, e, is proportional to the load up to the elastic limit, the work done upon the bar will be represented by the area of the triangle, 1/2 Pe. The stress in the bar increases in the same manner from 0 to P,

so that the figure also represents the internal energy stored in the bar.

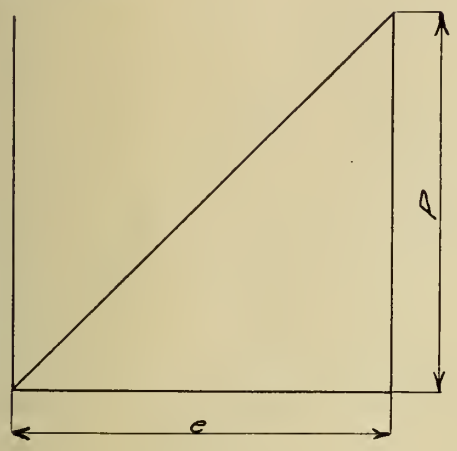


Fig. 1

Now taking the case in which the load is applied suddenly, it will be seen that the work done upon the bar by the sudden load P, in Fig. 2, when the bar has attained its maximum elongation, Q, is represented by the area of the rectangle, Pq. The internal energy stored in the bar that instant is 1/2 Qq, which must be equal to Pq. Hence Q = 2P.

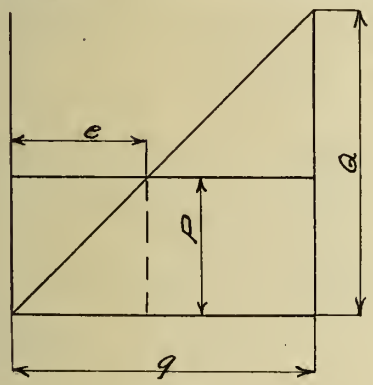


Fig. 2

If e is the elongation due to the static load P, then q/e = Q/P, and, therefore, Q = 2e. Since in this discussion, it was assumed that the elastic limit was not exceeded by Q, the following law is established for a bar under elastic changes of length:

> A sudden load produces double the stress and double the deformation that is caused by a static load.

That the effect of a suddenly applied load is independent of the stress that may be already in the bar, can be seen from a consideration of Fig. 3, in which e_1 represents the elongation due to a static load, P_1, and the other notation for loads and deformations are the same as in the previous discussions. When the

sudden load P is applied to the bar, causing the additional elongation, q, and the additional stress, Q, the figure shows that the total elongation is $e_1 + 2e$, and the total stress is $P_1 + 2P$, thus proving that the instantaneous load produces its effect independently of the other.

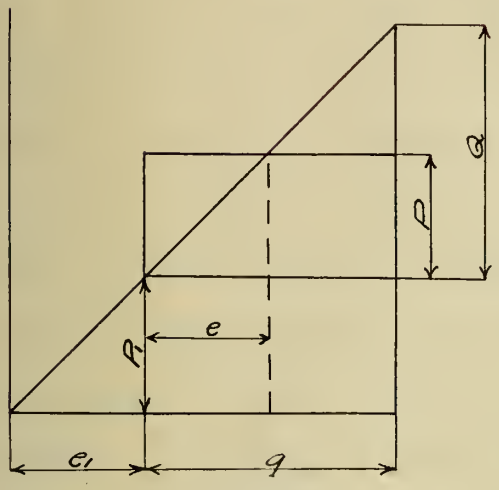


Fig 3

Practically the same discussion would apply to the deflection caused by a dynamic load upon a beam, and sincethe flexural unit stress at the dangerous section of a beam is proportional to the elastic deflection, it can be assumed that the law stated applies to beams as well as to bars.

If in addition to being applied suddenly, the load also has an initial velocity, V, the kinetic energy is $PV^2/2g$, where g is the acceleration due to gravity; or, if h is the height thru which P has fallen to acquire the velocity, V, then $V^2/2g = h$, and the kinetic energy of the moving load is Ph. If no work is expended in overcoming inertia or in friction, $1/2\ Qq = Ph$, (1) and if e is the deformation due to the static load P, then $q, e = Q, P$, (2), which combined with (1) gives

$$Q = P(2h/e)^{1,2} \quad \text{and} \quad q = (2he)^{1,2}.$$

From this, it is apparent that Q will be greater than P and q greater than e when V is large.

The chief difficulty of applying the foregoing discussion to stresses and deformations in highway bridges lies in the fact that the method of applying the loads to the members is entirely different from that assumed for bars or beams. This is particularly

true in the case of highway bridges which are subject to all manner of loading, from light rigs to heavy traction engines and their appurtenances which may cover the entire span of the bridge at one time. The load, however, is generally concentrated and does not cover the entire span. In addition to this, it was formerly a much debated question as to whether or not traffic crossing a bridge really constituted a suddenly applied load, since many bridge men argued that the load was in reality applied by increments. It can be readily understood, however, that the effect of a horse trotting over a bridge would be greater than if he were standing still upon it. Then, too, the effect of varying speeds as well as of traffic, and of difference in the design of bridges, would all have an influence on the stresses produced in the bridge. As far as deflection is concerned, the bridge as a whole will probably act very much as a beam.

It was to investigate some of these elements that this thesis was undertaken.

PLATE I.

DEFLECTOMETER ON INTERMEDIATE POST

EXTENSOMETER ON HIP VERTICAL

III. DESCRIPTION OF INSTRUMENTS.

In making the tests which follow two kinds of instruments were used; the deflectometer to measure the deflection of the bridge as a whole; and the extensometers, four in number, to measure the change in length of the individual members due to the moving loads passing over the bridge.

DEFLECTOMETER. PLATE I. PAGE 7. This instrument was devised by Professor F. E. Turneaure of Wisconsin University, being a modification of the original design by Professor Frankel of Dresden, Germany. This apparatus can be attached by means of clamps, to any member where the deflection of the structure is desired. The drums "B-B'", two in number, upon which the record paper is rolled, are operated by clock-work, and may be electrically controlled, the electro-magnet "C" being shown at the lower part of the instrument. The pencil "D" is attached to a steel ribbon "E", which passes over the steel wheels "F-F'" at each side of the paper roll. The ribbon is held taut by means of a second ribbon "G" which passes over the disc "H" of the wheel "F", and this is held in tension by means of a wire "I" connected to a heavy weight resting upon the river bed. When the bridge deflects, the tension in the wire is relieved and the pencil on the ribbon moves longitudinally across the paper; the paper in the meantime being set in motion, records the deflection of the member due to the load passing over the structure.

EXTENSOMETER. PLATE I. PAGE 7. The extensometers used in making these tests are also modifications of Professor Frankel's, being designed by Professor Turneaure in 1907. The instrument is attached to the member to be tested by means of clamps "A-A'", the clamps marked "A" being fixed, those marked "A'" hinged. The hollow rods, "B", which are about 3 feet in length, connect the instrument to another clamp which is also connected to the member. At the instrument end of the rod there is a device "C" for adjusting the pencil after the rod has been put in tension. The two paper drums "D" are operated by clockwork "E" and may be electrically controlled, the connecting wires "F" being clearly shown in the cut. In the interior of the instrument, there is a rod running from the connecting rod to the short end of the lever where there is a knife edge bearing. The long end of the lever "G" is very stiff and is made of aluminum in order to be as light as possible. At the end of the lever is an analine pencil "H", which records the movements of the lever on the paper passing from one drum to the other. The ratio of these lever arms is about 80 or 90 to 1.

PLATE 2.

GALLOPING ACROSS BRIDGE 4.

EXTENSOMETERS ON BRIDGE 4

AUTOMOBILE ON BRIDGE 5.

IV. METHOD OF MAKING TESTS.

Five instruments, in all, were used in making the following tests on the different bridges, four extensometers and one deflectometer. The deflectometer was clamped to the intermediate post nearest to the center of the bridge so as to obtain the greatest deflection of the structure as a whole. The extensometers were usually arranged in pairs on the different members, or in pairs on different parts of the same member. In this way the action of the different parts of the members due to the same conditions could be noticed.

An interesting comparison was made between Bridges No. 2 and No. 3, both bridges being of about the same span and designed for the same moving load. Bridge No. 3 has a plank flooring while that of Bridge No. 2 is concrete. The deflectometer and extensometers were placed similarly upon the two bridges, both as regards members and the extensometers used. The results of these tests are given in Article 6 of this thesis.

The instruments in place, and connected electrically in order to start the paper on all at the same time, the tests were begun. A series of readings were taken for each bridge for different speeds, and each reading numbered on each instrument together with the speed and direction of the moving load. The speeds in miles per hour, for all loads except for the automobiles, were taken from a curve shown in Graph 9, having given the time for the load to pass over a base line of 100 feet laid out across the bridge. This time was taken by means of a stop watch. The speeds for automobile loads were taken from the speedometer on the machine. The

different loads used in making these tests were (1) horse and double seated rig and driver; (2) double header, which was a horse and double seated rig and driver closely followed by horse and single seated rig and driver; and (3) a large touring automobile. The speeds attained with the horse and rig ranged from 3.5 to 24 miles per hour, and are treated under the three following headings: walk, "W", trot, "T", and gallop, "G"; and, when a double header was used, it is designated as "D-H"--"T", etc. The highest speed of the automobile reached 38 miles per hour as a limit, due to the poor approaches, the slowest speed being 5 miles per hour.

In explanation of the test curves shown at the end of this thesis, traced from originals taken in the field, the following examples are given; D-1, 20 m. p. h., indicating test No. 1 on deflectometer with speed of 20 miles per hour; E-2 - 154 - 5 m. p. h. "T", indicating test No. 154, taken on extensometer No. 2, the speed being 5 miles per hour; T signifying trot, "G", gallop, etc. If "D-H" is added, the moving load was a double header as given in (2) above. The bridge tested, together with the member of that bridge and the position of the instruments on the bridge, as well as the moving load, are all given in the title at the top of the sheet.

PLATE 3.

BRIDGE No. 5 SPAN 160 FEET

RIG CROSSING BRIDGE No. 5

AUTOMOBILE CROSSING BRIDGE No. 5

V. DESCRIPTION OF BRIDGES TESTED.

The bridges tested in this thesis were;

(1). MARKET STREET BRIDGE.

(2). BLACKBERRY BRIDGE.

(3). SCHWARTZ BRIDGE.

(4). ST. JOE BRIDGE.

(5). MAHOMET BRIDGE. (160 foot span).

(6). MAHOMET BRIDGE. (144 foot span).

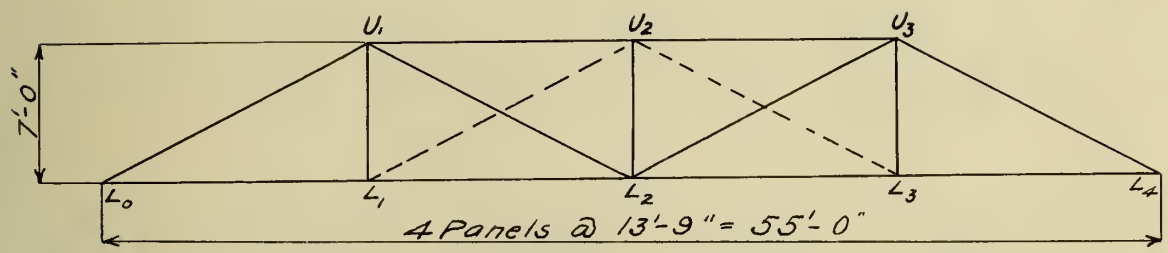


Fig. 4. Bridge No. 1.

BRIDGE No. 1. This is known as the Market St. Bridge and is located north of the city district of Urbana, on Market St. across the Salt Fork drainage ditch. It is a highway bridge on one side of which a sidewalk is supported by brackets. All tests were made on the truss furtherest from the sidewalk as it was impossible to attach instruments to the lower chord on the side where the cantilever sidewalk was hung.

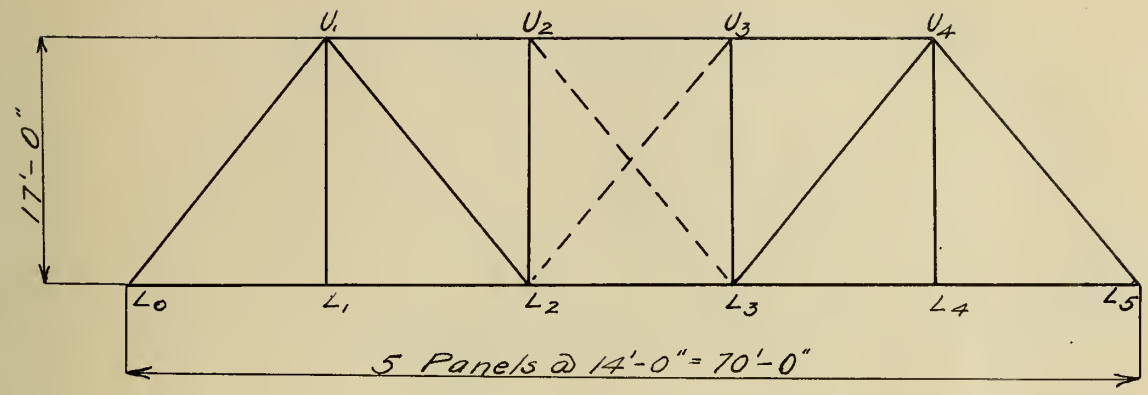


Fig. 5. Bridge No. 2.

BRIDGE No. 2. The Blackberry Bridge is located east of Urbana, and it also crosses the Salt Fork drainage ditch. It is about 3 miles east of the Market St. Bridge. The flooring is plank. The clearance between trusses is 14.0 feet.

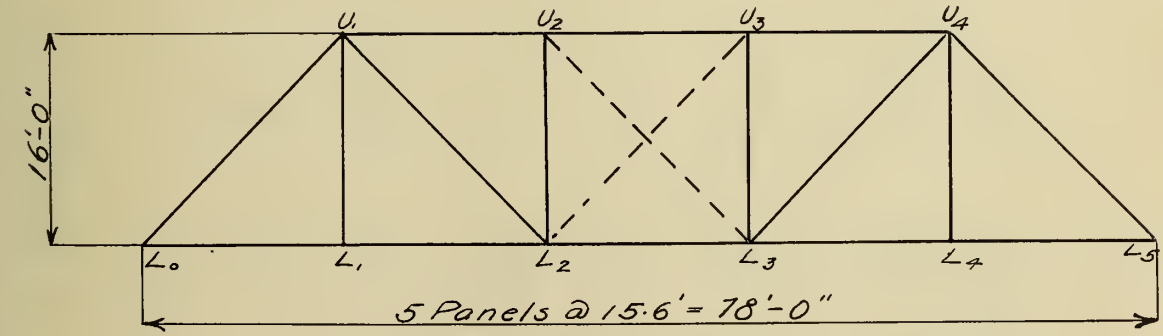


Fig. 6. Bridge No. 3.

BRIDGE No. 3. The Schwartz Bridge is located across the Salt Fork drainage ditch about half way between the Blackberry Bridge and the Market St. Bridge. From the dimensions given it can be seen that the Blackberry Bridge and the Schwartz Bridge are similar. The roadway clearance is 14.0 feet, the flooring being reinforced concrete.

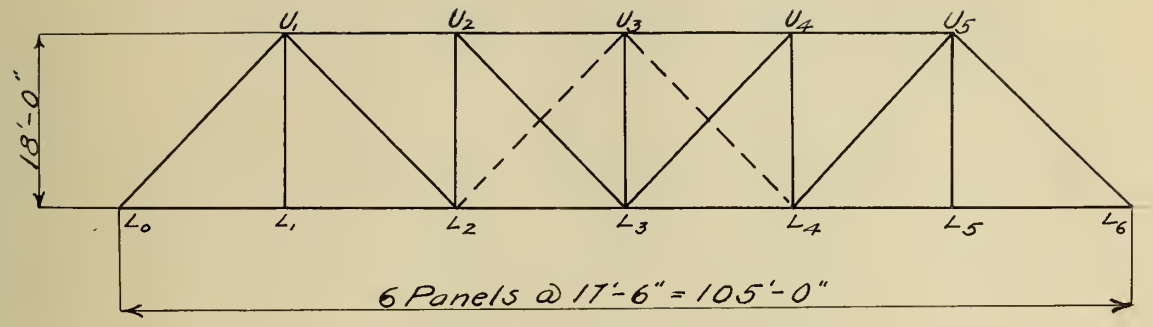


Fig. 7. Bridge No. 4.

BRIDGE No. 4. The St. Joe Bridge is located just west of St. Joe, Illinois, across the Salt Fork branch of the Illinois River. The bridge has a roadway clearance of 16.0 feet and a flooring of plank.

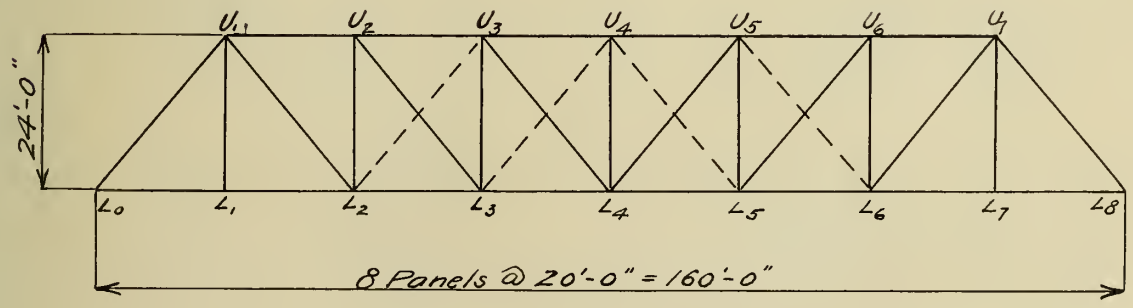


Fig. 8. Bridge No. 5.

BRIDGE No. 5. This bridge is located about one mile and a half southwest of Mahomet, Illinois, crossing the Sangamon River. The roadway clearance is 17 feet and the flooring is of plank.

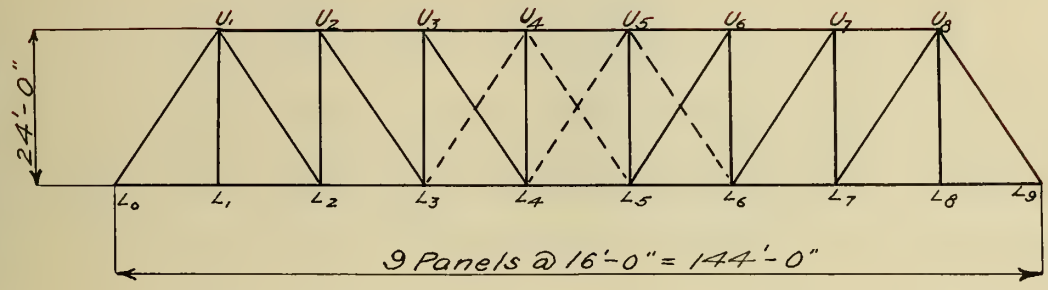


Fig. 9. Bridge No. 6,

BRIDGE No . 6. This bridge is also located in the neighborhood of Mahomet, crossing the Sangamon River about 3 miles northeast of town. The roadway clearance is 14 feet, the flooring being of concrete. The approach to this bridge from the west is through a deep cut and on a curve, while at the other end there is a steep grade upon leaving the bridge. Consequently, no fast speeds were obtained in making the tests upon this structure.

VI. RESULTS OF TESTS.

Although the extensometers used in these tests have been calibrated to measure stress, no attempt was made to determine the amount of stress in any of the bridge members. The one thing needed for this thesis was the amount of the impact, or the excess of the live-load stress over that produced by the static load.

In order to determine this a line ABC (Fig. 10) was drawn through the middle points of the stress diagram and the distance CE was assumed to represent the static stress. One hundred times the ratio of the distance CD to the distance CE would then represent the percent of impact. In case the top of the loop was closed, no account was taken of the diagram above D as this was due to instrumental vibrations.

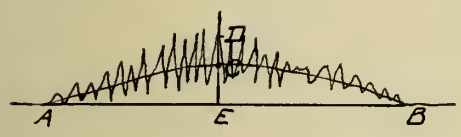


Fig. 10.

The stress diagrams show clearly that bridge members are subjected to a series of elongations and contractions whenever traffic passes over the bridge. They further show that the effect of impact varies greatly in the different members, and they are particularly good in showing the reversal of stress likely to be produced in the lower chord. Contrary to expectations, it was also found that the stress produced by a light rig is generally greater than that produced by a much heavier automobile. This is, in all probability, due to the fact that the pounding of the horses hoofs sets up cumulative vibrations which greatly add to the stress produced by direct impact.

An excellent comparison was noted between the Blackberry bridge with a plank floor and the Schwartz bridge of practically the same span with a concrete floor. Since the proportion of dead load to live load was greater in the latter case it was but natural to suppose that the percent of impact would be less, and this was found to be true.

Graphs were made showing the maximum percent of impact in different classes of members for all six bridges, and by means of these, an attempt was made to establisn a relation between percent of impact and length of span. Nothing very satisfactory was obtained, however, on account of the fact that so many other elements entered into the experiment. Perhaps an average value for impact would give a more reliable curve than that plotted from just the mere maxima. It was found that the speed at which a load passed over the bridge had a marked effect upon the amount of impact produced. Graph 5 shows the increase in percent of impact in compression members due to increasing speed. It further shows that beyond a certain point, which might be called critical speed, the percent of impact diminishes. The best example of critical speed occurred in testing Bridge No. 6, when a horse trotted over the bridge at the rate of 10.5 miles per hour. The stresses in all the members for this speed proved to be far in excess of those for any other speed.

The critical speed for any bridge, however, is perhaps best detected by means of the deflectometer, as was shown by the deflectometer diagrams for Bridge No. 6.

In order to determine the amount of static deflection, a

reading was taken with the load standing, or moving very slowly over the bridge. The distance a b' (Fig. 11) represents the

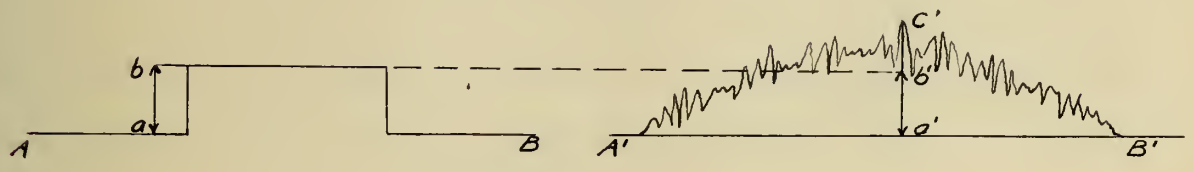


Fig. 11

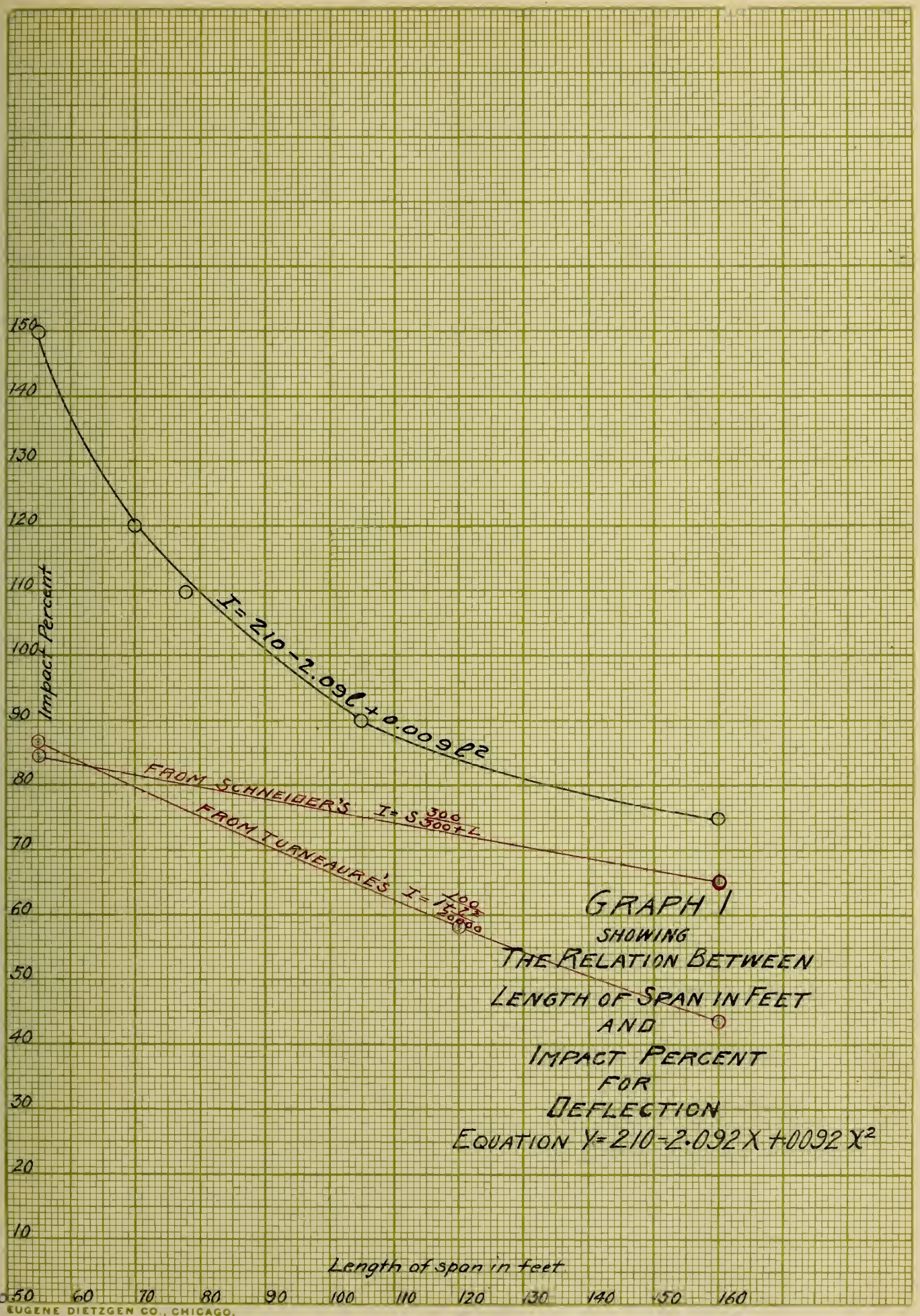
static deflection, and the distance b'c' in the diagram for the moving load represents the amount of impact deflection.

A very satisfactory curve was obtained by plotting the maximum impact deflections as ordinates and the length of the span as abscissa. This curve shows that impact deflection decreases with the length of span but not in direct proportion, and it would seem to indicate that the stresses in the members should vary in much the same way. The deflection-span curve, in which the reading for the critical speed was omitted, does not check with Schneider's or Turneaure's formulae for railway bridges, as is shown by a comparison of the curves in Graph 1.

A relatively enormous value was obtained for the deflection of Bridge No. 6 when the critical speed of 10.5 miles per hour was attained. It is quite probable that the time of vibration of the bridge coincided with the hoof-beats of the horse, so that great deflection was produced by cumulative vibrations. It is worthy of mention that the stresses in all the bridge members at this time were far in excess of those for other speeds.

Several other graphs were plotted showing the relation of the percent of impact deflection to the speed. Graph No. 6 shows that beyond certain speeds the deflection of bridges under automo-

bile traffic begins to decrease, wnile Graphs 7 and 8 show the same thing for ordinary carriage traffic. The curve for Bridge No. 6 shows clearly that the critical speed was 10.5 miles per hour, while for Bridges No. 3 and 5 the curve seems to indicate that the critical speed is somewhere between 10 and 12.5 miles per hour.



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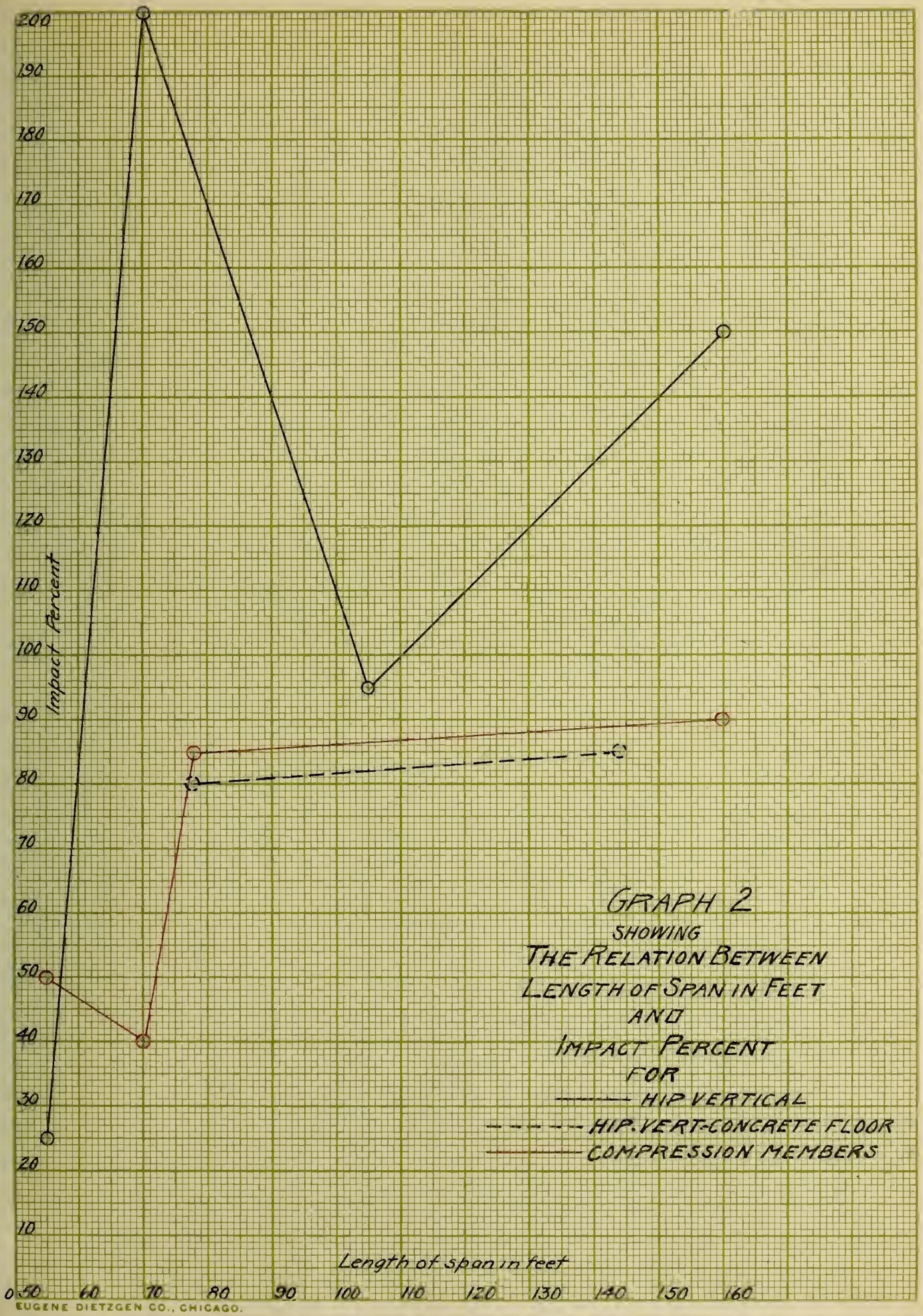

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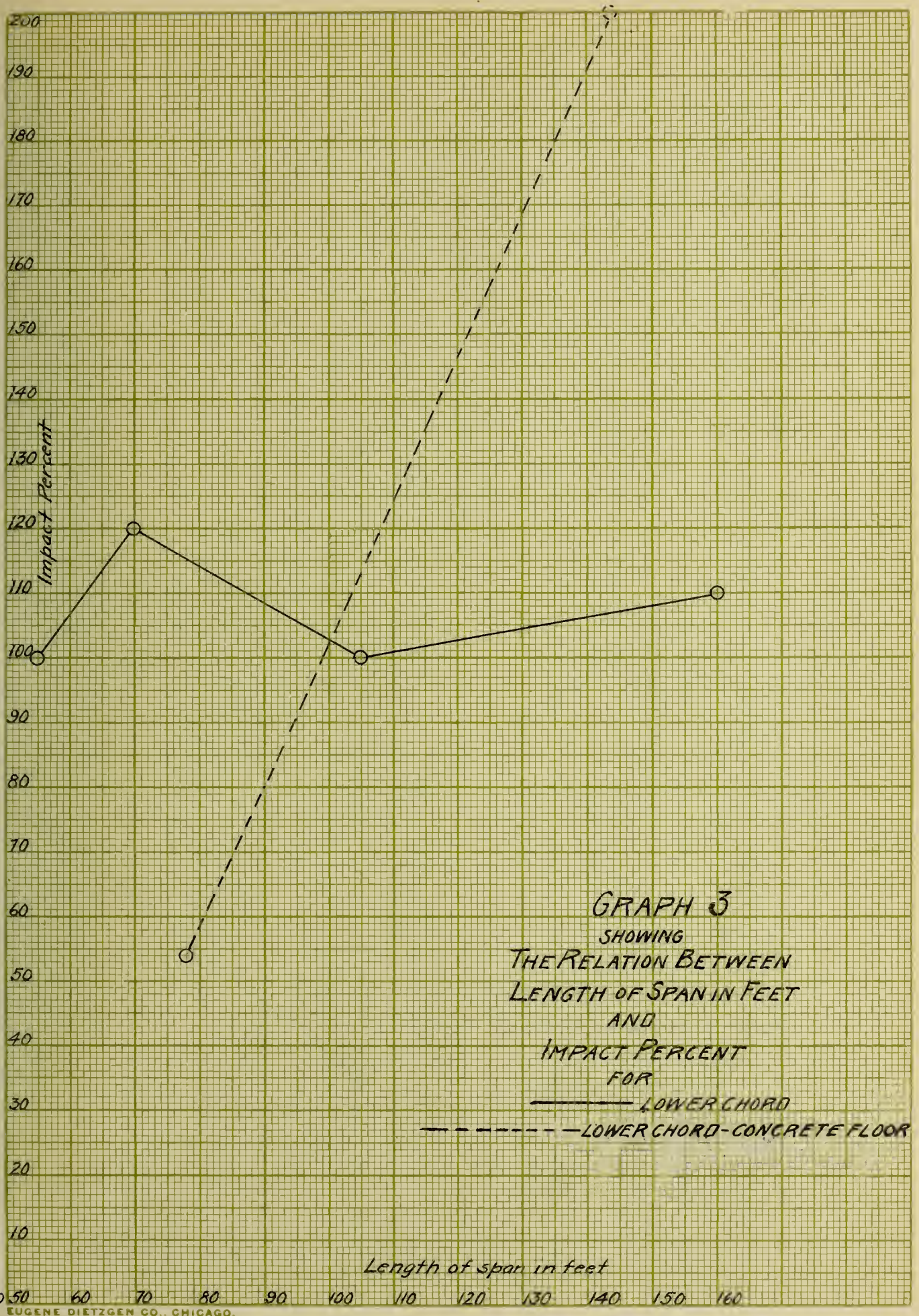

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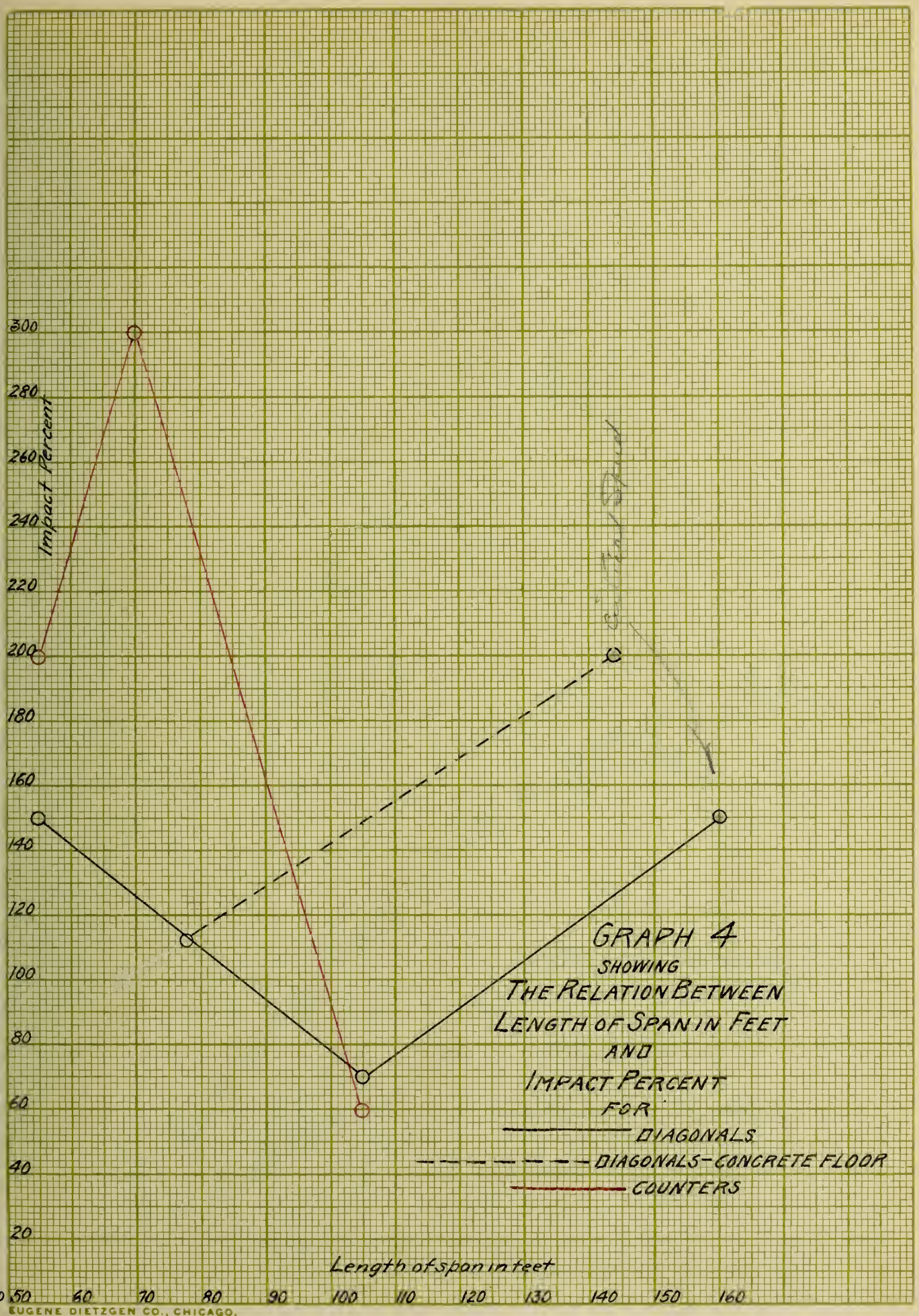

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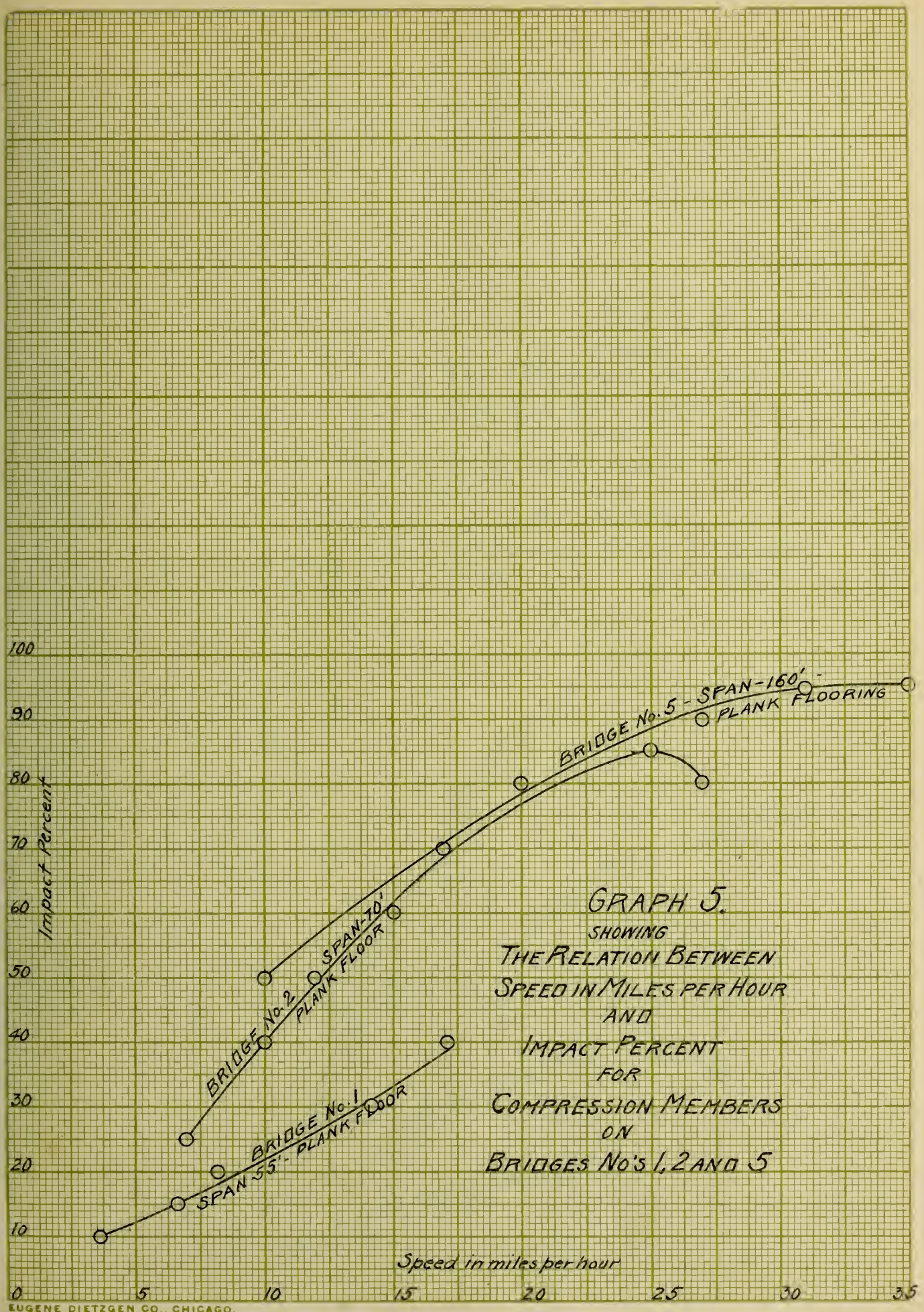
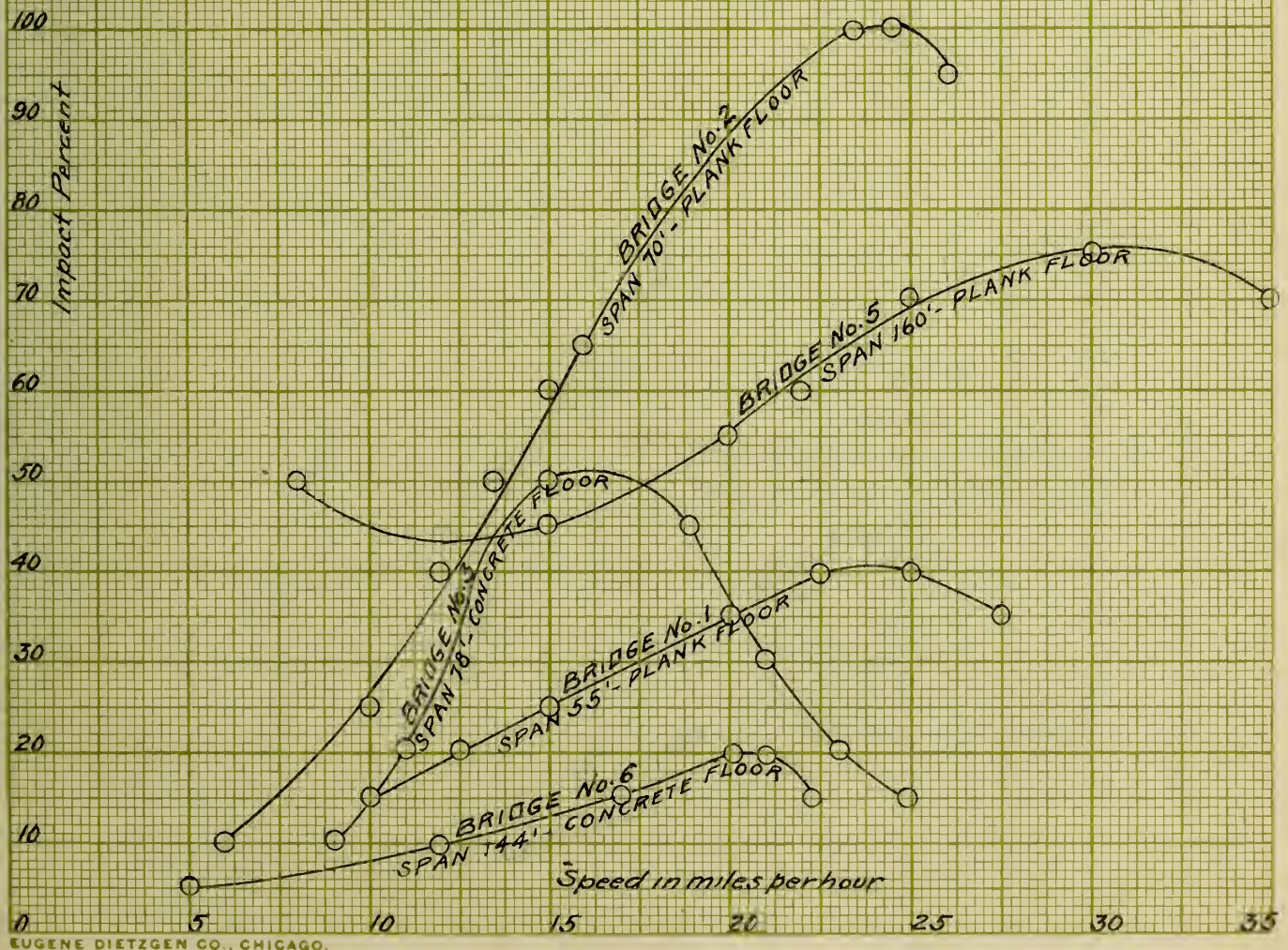


GRAPH 5.
SHOWING
THE RELATION BETWEEN
SPEED IN MILES PER HOUR
AND
IMPACT PERCENT
FOR
COMPRESSION MEMBERS
ON
BRIDGES No's 1, 2 AND 5

EUGENE DIETZGEN CO., CHICAGO.

GRAPH 6
SHOWING
THE RELATION BETWEEN
SPEED IN MILES PER HOUR
AND
IMPACT PERCENT
FOR
DEFLECTION
ON BRIDGES No's 1, 2, 3, 5 AND 6
LOAD - - - - - - - - - AUTOMOBILE



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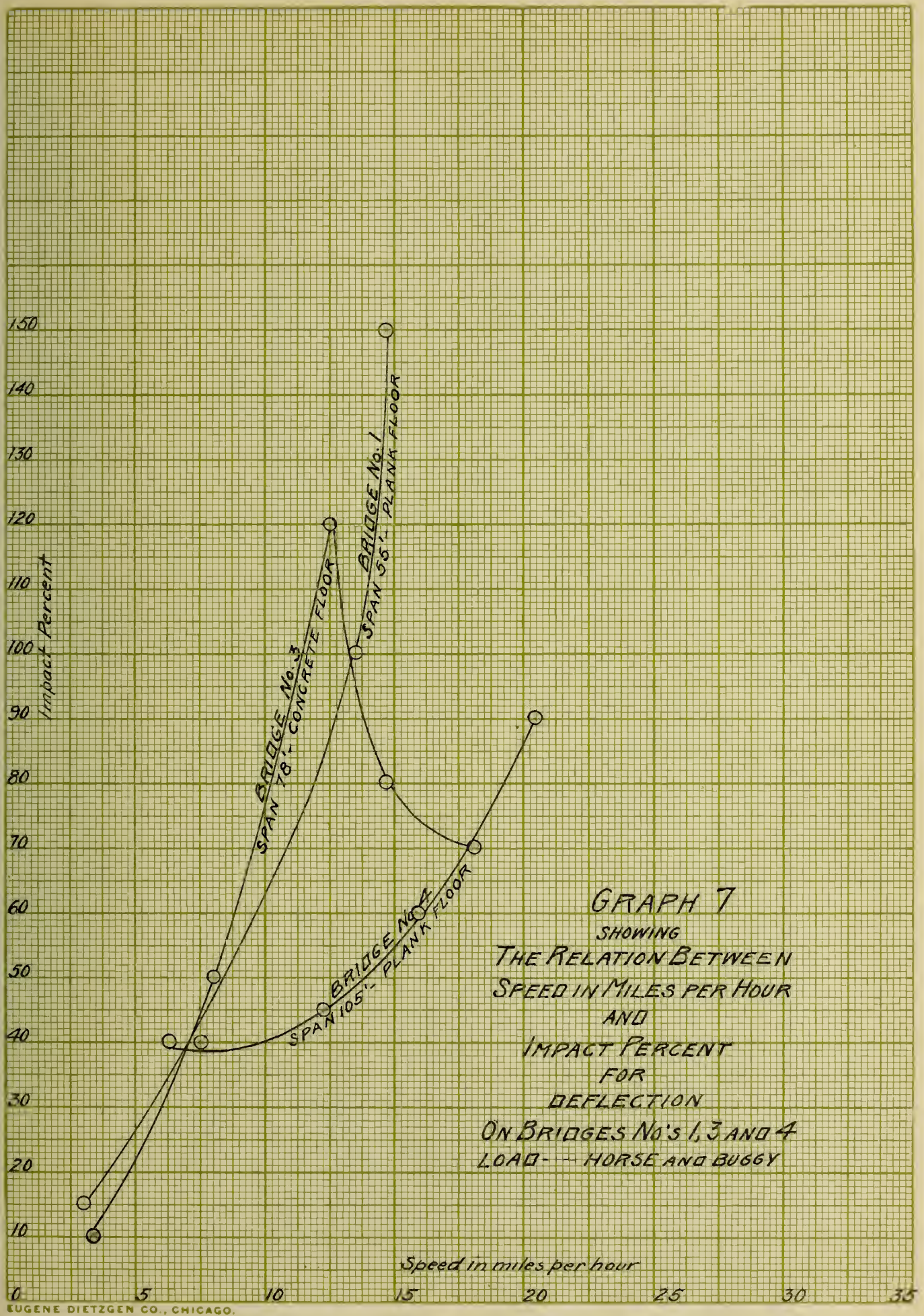

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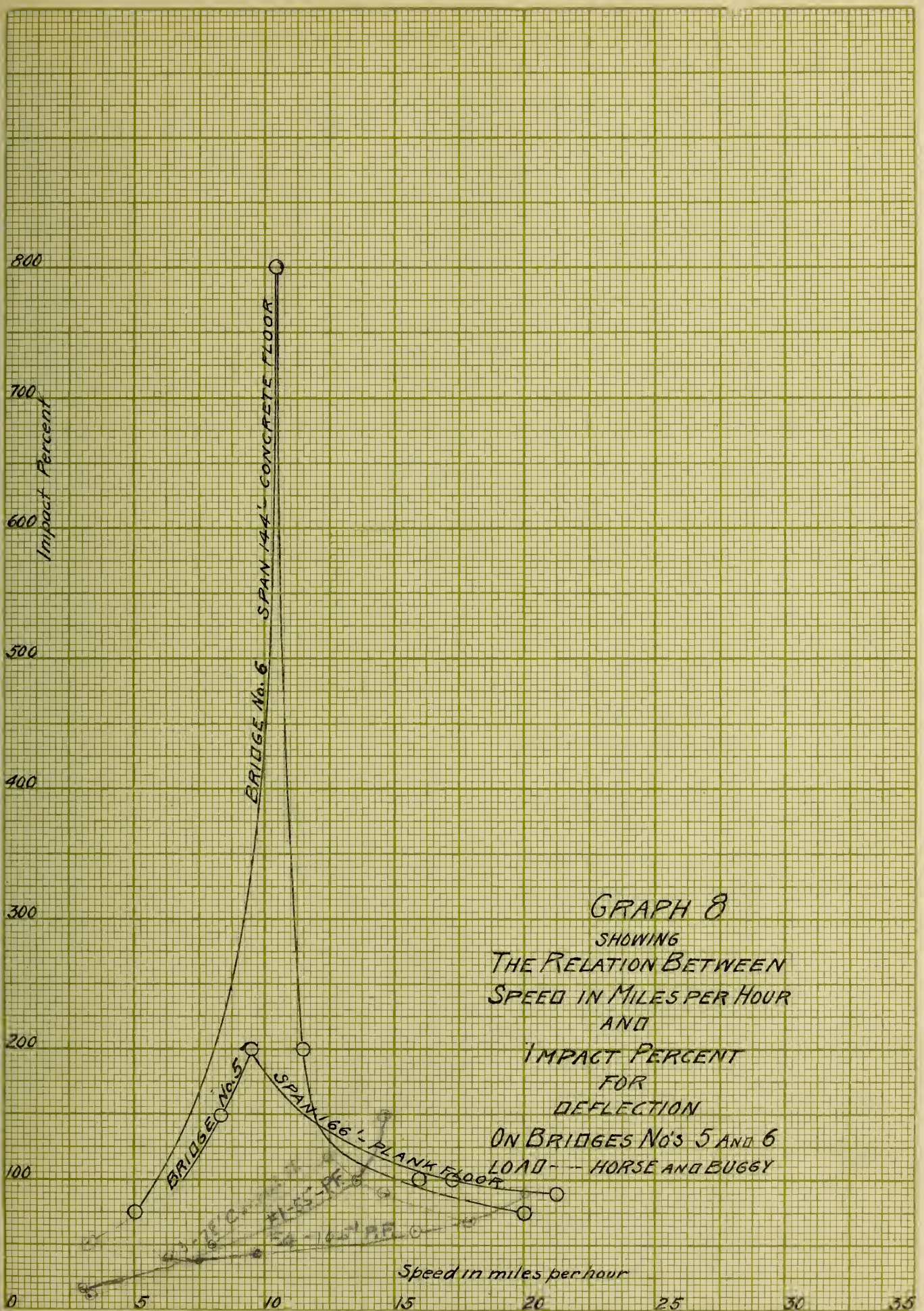
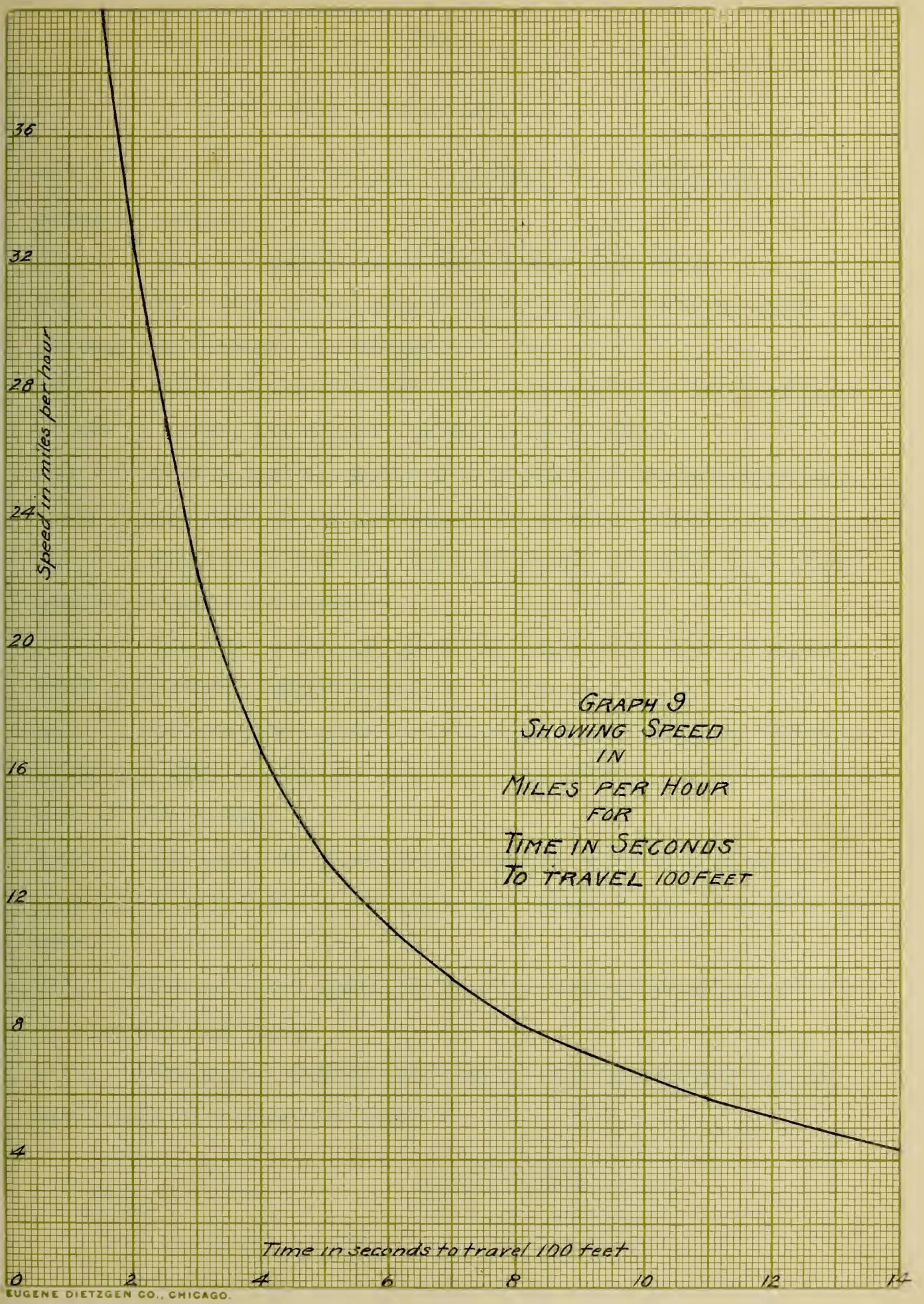


GRAPH 8
SHOWING
THE RELATION BETWEEN
SPEED IN MILES PER HOUR
AND
IMPACT PERCENT
FOR
DEFLECTION
ON BRIDGES No's 5 AND 6
LOAD - - HORSE AND BUGGY

EUGENE DIETZGEN CO., CHICAGO.



EUGENE DIETZGEN CO., CHICAGO.

VII. CONCLUSIONS.

(1). The amount of impact is greater for tension than for compression members.

(2). Built up members have less impact than bars.

(3). End lower chords should be built up members in order to provide for reversal of stress.

(4). When the ratio of the live load stress to the dead load stress is large, the percent impact is also large.

(5). Less impact is produced in members of bridges with concrete floors than in the members of those with plank floors.

(6). Automobile traffic, light or heavy, produces less impact than light carriage traffic.

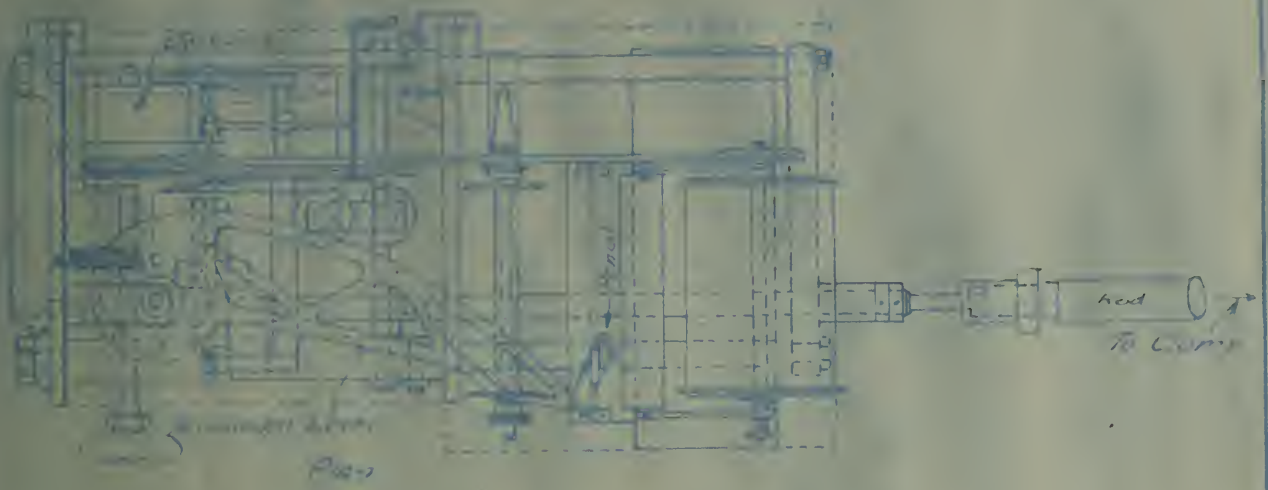
(7). There is a certain speed for automobile traffic beyond which the percent impact ceases to increase.

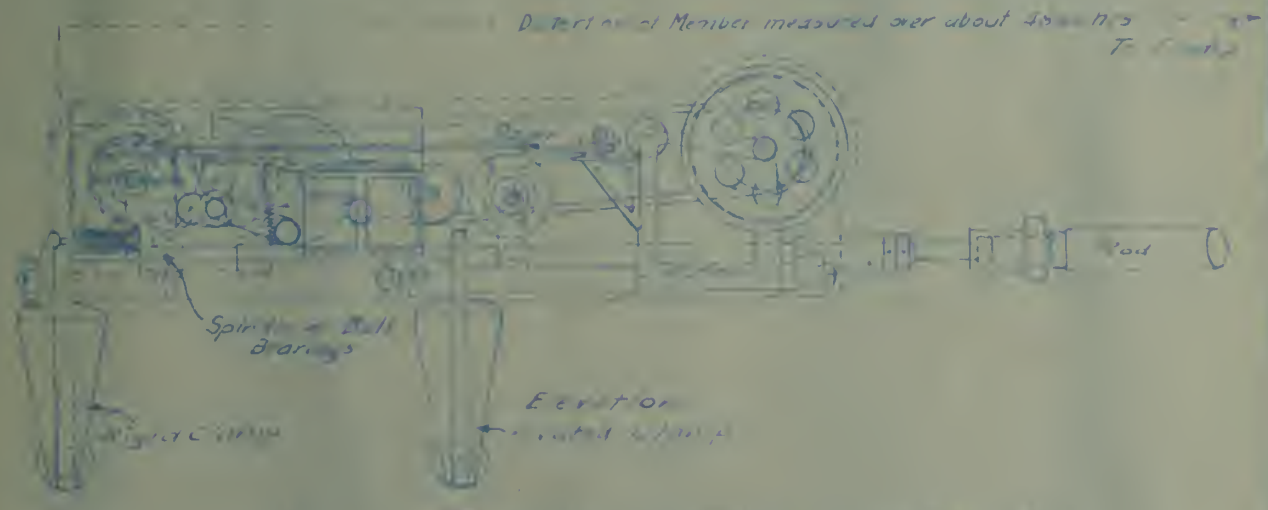
(8). The critical speed for carriage traffic is that speed at which the steps of the horse are in time with the period of vibration of the bridge.

(9). The critical speed for Bridge No. 6 is 10.5 miles per hour and that for Bridges 3 and 5 is between 10 and 12.5 miles per hour.

(10). The critical speed can best be determined by means of deflectometer readings.

(11). Empirical formulae deduced for railway bridges are not applicable to highway bridges.





Extensometer Recording

D 104 115 Deflectometer on outside flange of U_2L_2 Bridge * 1

D 104 112 Automobile

D 106 15 m.p.h

D 105 10 m.p.h.

D 104 12.5 m.p.h.

D 109 25 m.p.h

D 110 22 m.p.h.

D 108 27 m.p.h

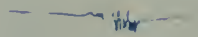
D 107 20 m.p.h

D 112 Static

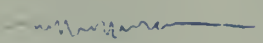
Rear Wheel at L_3 Front Wheel at L_3 Front Wheel at L_2 Front Wheel at L_1

D 111 27 m.p.h

D 113-115 Horse and 2-seated Rig



D 115 4.8 m.p.h



D 114 13.5 m.p.h.

D 113 3 m.p.h.

Deflectometer on Bridge # 3 - Concrete Floor - Load - Horses & Rigs D 122 - 147

Deflectometer on U_2L_2 D 122 - 132

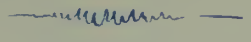
D 124 10.0 m.p.h. "T"

D 125 9.9 m.p.h "T"

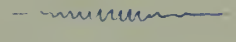
D 130 8 m.p.h. "d.h.T."

D 123 3.6 m.p.h "W"

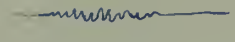
D 122 3.4 m.p.h "W"



D 127 18 m.p.h. "G"



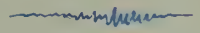
D 126 18 m.p.h. "G"



D 128 14.7 m.p.h "G"

D 132 12.5 m.p.h. "d.h. G"

Deflectometer on U_3L_3 D 133 - 147



D 146 10.7 m.p.h. "d.h. T."

D 134 9.8 m.p.h. "T"

D 144 9.1 m.p.h. "T"

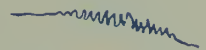
D 140 9.1 m.p.h. "T"

D 133 8.8 m.p.h. Trot

D 145 15.3 m.p.h. "G."

D 143 15.3 m.p.h. d.h. "G."

D 139 13.5 m.p.h. d.h. "G"



D 135 12.5 m.p.h. "G."

D 142 11.2 m.p.h. d.h. "T."

D 138 11.0 m.p.h. d.h. "T."

"W" - Horse Walking
"T" - Horse Trotting
"G" - Horse Galloping
d.h. 1 single Rig followed 1 double Rig (double header)
m.p.h. miles per hour

D 136 18 m.p.h. "G"

D 141 17 m.p.h. "G"

D 137 17 m.p.h. "G"

Bridge #4 Span 105' Deflectometer on outside flange of U_3L_3 Load - Horse and Buggy

D-186 - 3.4 m.p.h "W"

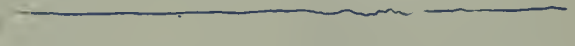
D-185 - 3.4 m.p.h "W"

D-188 - 5.4 m.p.h "T"

D-187 - 9.8 m.p.h "T"

D-191 - 3.4 m.p.h "W"

D-190 - 12.0 m.p.h "G"



D-189 - 16.1 m.p.h "G"

D-194 - 7.5 m.p.h. "T"

D-193 - 6.2 m.p.h. "T"

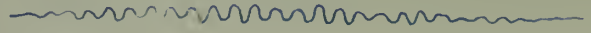
D-192 - 3.4 m.p.h "W"

D-196 - 20.5 m.p.h "G"

D-195 - 16.0 m.p.h "G"

Bridge #5 Deflectometer on U_4L_4

Load 208-212 Horse and buggy 213-218 and 226-229 Automobile



210 - 9.5 m.p.h "T"

209 - 8.4 m.p.h "T"

208 - 2.7 m.p.h. "W"

213 - Static - Auto

212 - 21.5 m.p.h "G"

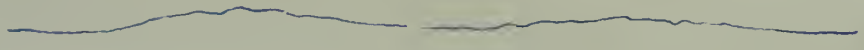
211 - 17.2 m.p.h "G"

215 - 22 m.p.h

214 - 8 m.p.h.

218 - 15 m.p.h. 217 - 30 m.p.h

216 - 7.5 m.p.h.



229 - 30 m.p.h 228 - 25 m.p.h

227 - 35 m.p.h 226 - 20 m.p.h.

Bridg#6 Span 144' Concrete Floor Loads: 280-285 Automobile
289'-290, 286 Horse and Rig

Deflectometer on middle post

Automobile Load

D 282 17 m.p.h.

D 284 12 m.p.h.

D 285 5 m.p.h.

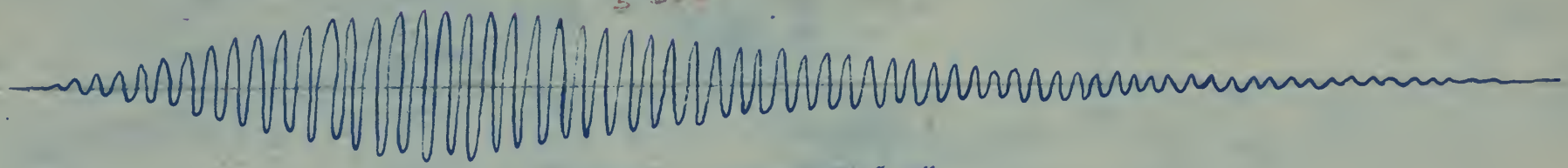
D 280 22 m.p.h.

D 283 21 m.p.h.

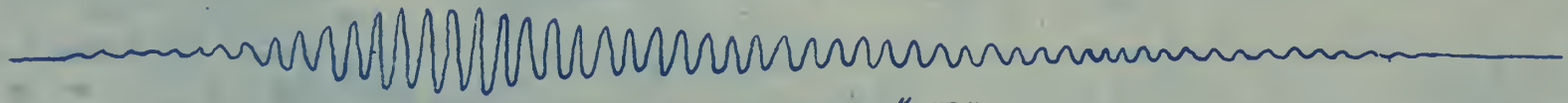
D 281 20 m.p.h.

Horse and Rig Load

D 289' 5.0 m.p.h. "W"

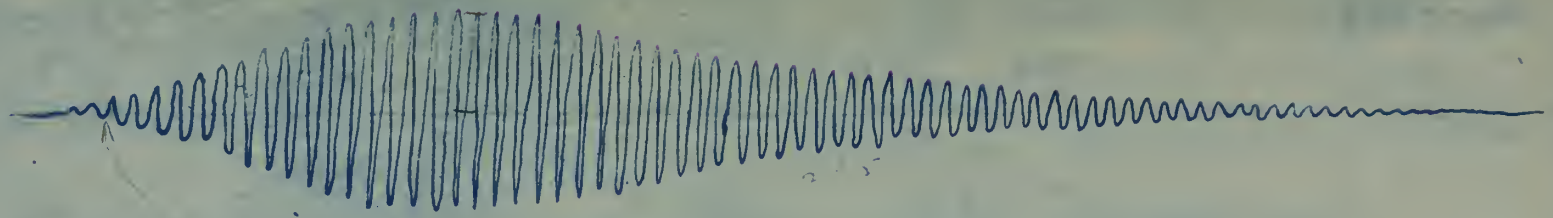


D 290 9.8 m.p.h. "T"



D 286 10.1 m.p.h. "T"

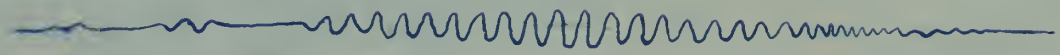
Bridge #6 Span 144' Concrete Floor Load: Horse and Rig
Deflectometer in Center



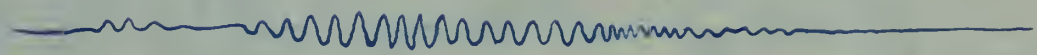
D 295 10.5 m.p.h. "T"

D293 11.0 m.p.h. "T"

D 291 10.6 m.p.h. "T"



D292 11.5 m.p.h. "T"



D287 11.8 m.p.h. "T"

D294 20 m.p.h. "G"

D 289 17.5 m.p.h. "G"

[illegible] 16.0 m.p.h. "G"

Deflectometer Diagrams. Comparison of Br 2 (plank floor) & Br. 3 (concrete floor)
Equal spans, speeds, & loads

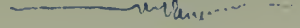
Load - Automobile

Spans - 78 ft.

Br. 2 D 159 10 m.p.h.

Br. 2 D 152 10 m.p.h

Br. 2-157 6 m.p.h.



Br. 2 D 150 6 m.p.h

Br. 3 D 171 11 m.p.h.

Br. 3 D 170 9 m.p.h.

Br. 3 D 172 6 m.p.h.

Br. 3 D 179 5 m.p.h.

Br. 2 D 151 23 m.p.h

Br. 2 D 149 16 m.p.h.

Br. 2 D 156 15 m.p.h.

Br. 2 D 161 13 m.p.h.

Br. 2 D 154 12 m.p.h.

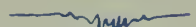
Br 3 D 171 23 m.p.h.

Br. 3 D 176 21 m.p.h.

Br. 3 D 175 19 m.p.h.

Br. 3 D 174 15 m.p.h.

Br. 2 D 162 26 m.p.h



Br. 2 D 155-26 m.p.h

Br. 2 D 153 26 m.p.h.

Br. 2 D 160-24 m.p.h.

Br. 2 D 158 24 m.p.h

Br. 3 D 178 25 m.p.h.

Br. 3 D 173 25 m.p.h.

Extensometer on inside hip vertical Br. #1 107-121 Automobile 107-112 Rig 113-121

Es 109 25 m.p.h.

Es 108 20 m.p.h.

Es 107 20 m.p.h.

Es 112 0.0 m.p.h.

Es 111 27 m.p.h.

Es 110 22 m.p.h.

Es 115 14.8 m.p.h.

Es 114 13.5 m.p.h.

Es 113 3 m.p.h.

Es 118 17 m.p.h.

Es 117 17 m.p.h.

Es 116 12 m.p.h.

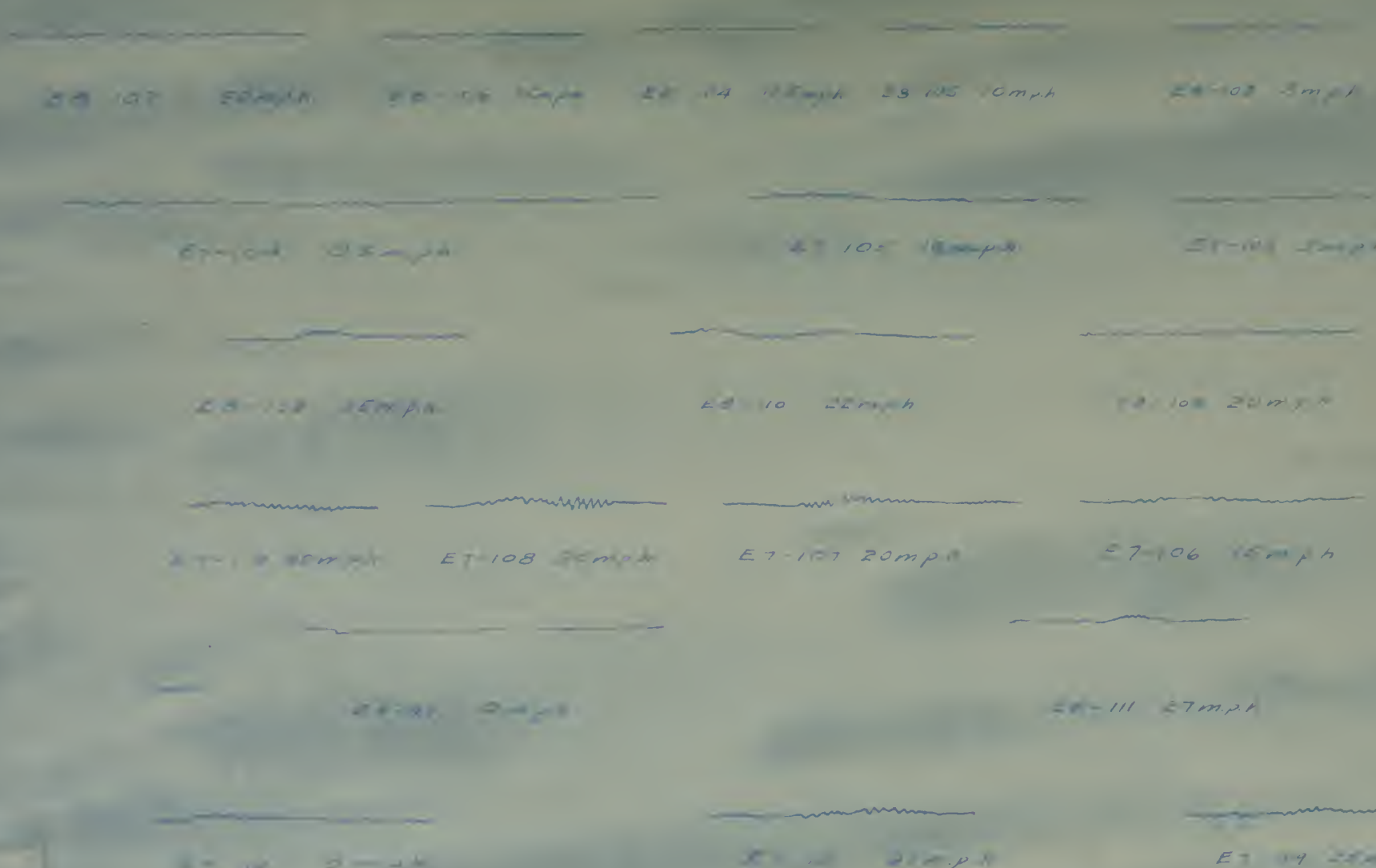
Es 121 3.8 m.p.h.

Es 120 4.2 m.p.h.

Es 119 10 m.p.h.

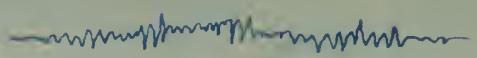
(40)

Smidge #1 High Vertical Use Es on middle bar E7 on outside bar
Automobile load



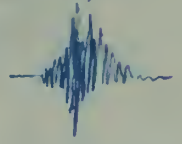
Bridge #2 Hip Vertical U_4L_4 E_7 on inside E_4 on outside

Load - Automobile

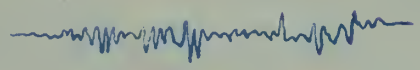


E_7 - 152 - 10 m.p.h

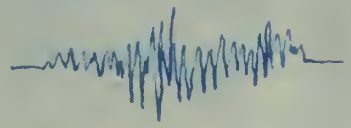
E_4 - 152 - 10 m.p.h



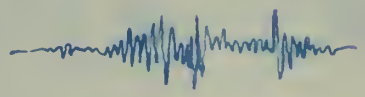
E_7 - 149 - 16 m.p.h.



E_4 - 149 - 16 m.p.h.



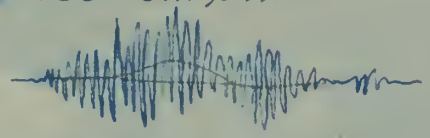
E_7 - 153 - 26 m.p.h



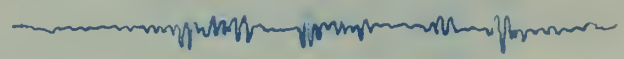
E_4 - 153 - 26 m.p.h

E_7 - 150 - 6 m.p.h.

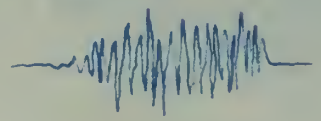
E_4 - 150 - 6 m.p.h.



E_7 - 154 - 12 m.p.h.



E_4 - 154 - 12 m.p.h.



E_7 - 151 - 23 m.p.h.

E_4 - 151 - 23 m.p.h.

Bridge #3 Hip Vertical U1L1 E_8 on inside E_2 on outside

Load - Automobile

E_8 - 170 - 9 m.p.h.

E_2 - 170 - 9 m.p.h.

E_8 - 172 - 0 m.p.h.

E_2 - 172 - 6 m.p.h.

E_8 - 175 - 19 m.p.h.

E_2 - 175 - 19 m.p.h.

E_8 - 174 - 15 m.p.h.

E_2 - 174 - 15 m.p.h.

E_8 - 173 - 25 m.p.h.

E_2 - 173 - 25 m.p.h.

E_8 - 171 - 23 m.p.h.

E_2 - 171 - 23 m.p.h.

Bridge 3; Span 78'; Concrete floor. Hip Vertical U.L.; E8 on inside, E2 on outside

Load { Horse, double seated rig & driver
d.h. " " " " " " " + same with single rig

E8 128

14.7 m.p.h. "G"

E2 128

E8 125

9 9 m.p.h. "T"

E2 - 125

E8 123

3.6 m p h. "W"

E2 123

E8 - 124

3.1 m p.h "d h. W"

E2 129

E8 127

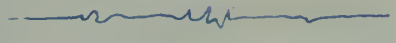
18 m p h "G"

E2 127

E8 126

18 m p.h. "G"

E2 126



E8 - 131

14.0 m.p.n "d h. G"

E2-130

E8 132

12.5 m p.h. d.h. "G"

E2-130

E8 - 130

80 m p h. "d h T."

E2 - 130

(44)

Bridge #4 - H.P. Vertical U.L. - E7 on inside E8 on outside
Load - Horse and light double seated rig

E7 - 185 - 3.4 m.p.h. W

E8 - 185 - 3.4 m.p.h. "W"

E7 - 187 - 9.8 m.p.h. "T"

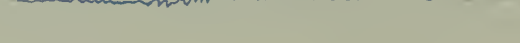
E8 - 187 - 9.8 m.p.h "T"

E7 - 189 - 16.1 m.p.h. "G"

E8 - 189 - 16.1 m.p.h "G"

E7 - 186 - 3.4 m.p.h "W"

E8 - 186 - 3.4 m.p.h. "W"



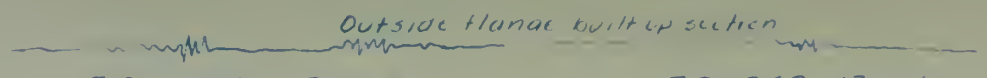
E7 - 188 - 5.4 m.p.h "T"

E8 - 188 - 5.4 m.p.h "T"

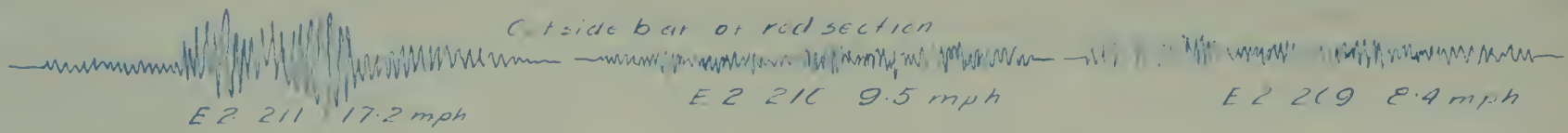
E7 - 190 - 12.0 m.p.h. "G"

E8 - 190 - 12.0 m.p.h. "G"

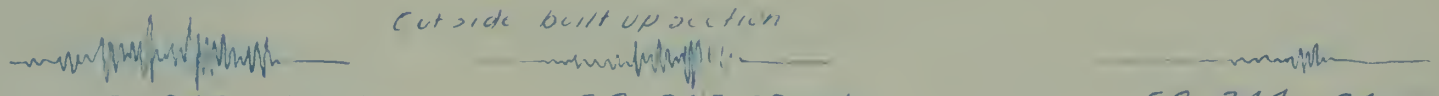
Hip Vertical U.L. Br 5 241-244 209 212 Horse Rng 245-249 215-218 Automobile



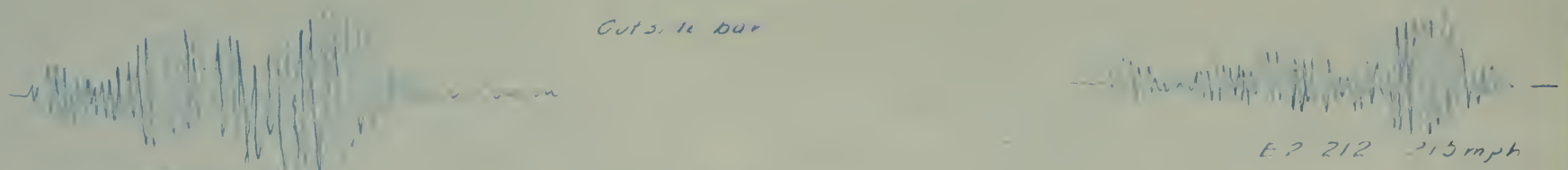
E8 243 17 mph. E8 242 13mph E8 241 11mph



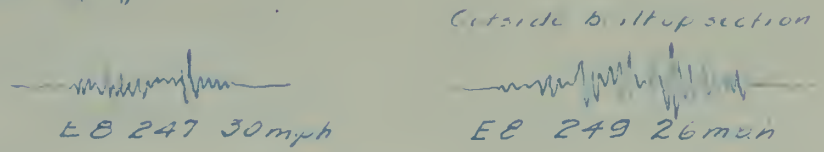
E2 211 17.2 mph E2 210 9.5 mph E2 209 8.4 mph



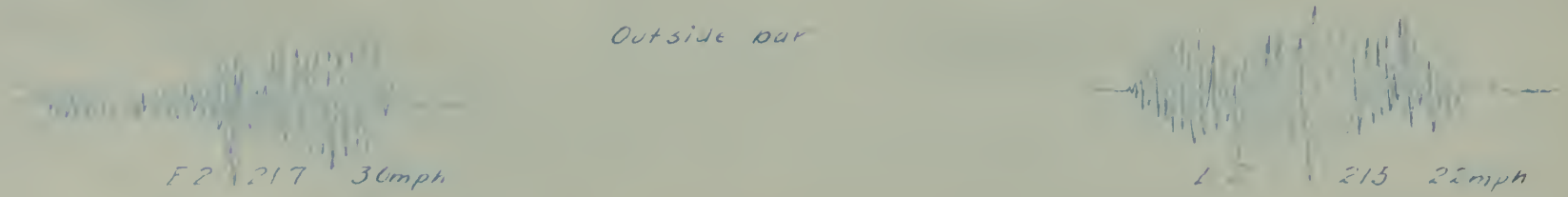
E8 248 15 mph E8 245 37mph. E8 244 24 mph



E2 218 15 mph E2 212 21.5 mph

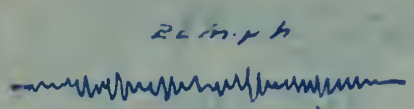


E8 247 30mph E8 249 26mph E8 246 20mph.



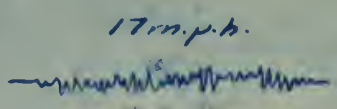
E2 217 30mph E2 215 25mph

Bridge #6 Span 144' Concrete Floor Hip Vertical L, U, Load: Automobile
E2 on inside bar So. truss; E8 on outside bar. E4 on inside, E1 on outside bar north truss



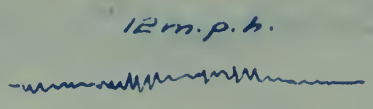
22 m.p.h.

E 2-280



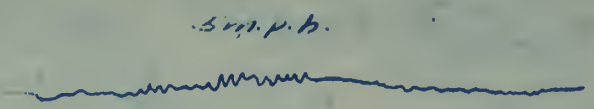
17 m.p.h.

E2 282



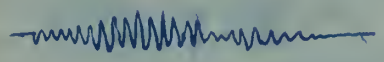
12 m.p.h.

E2 284

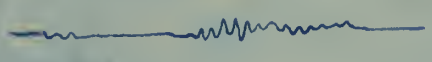


5 m.p.h.

E2 285



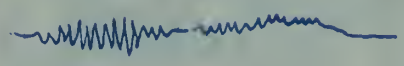
E 8-280



E8 282

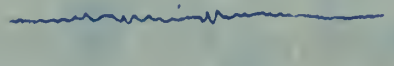
E8 284

E8 285



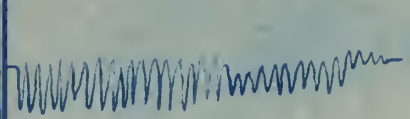
E4 280

E4 282

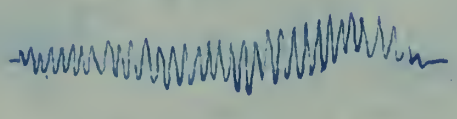


E4 284

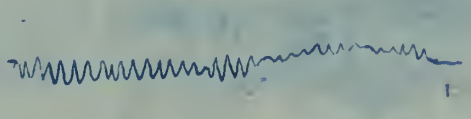
E4 285



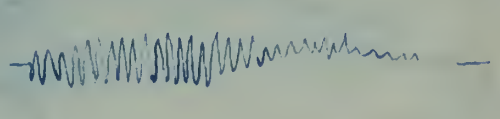
E 7 280



E 7 282



E7 284



E7 285

(47)

Bridge #6 Span 144' Concrete Floor Hip Vertical L. J. Load: Horse and Rig

E2 on inside bar, South Truss

E3 on outside bar, South Truss

E4 on inside bar North Truss

E7 on outside bar North Truss

Diagrams showing effect of automobile on Br 2 and Br 3 Br 2 plank floor Br 3 concrete floor

Br 2 out hip vertical 12 m.p.hr
E 4 154

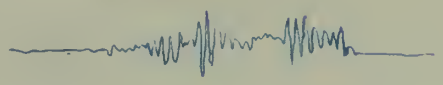
Br 2 out hip vertical 10m.p.hr
E 4 152

Br 2 out hip vertical 6m.p.hr
E 4 150

Br 3 out hip vertical 15 m.p.hr
E 2 174

Br 3 out hip vertical 9m.p.hr
E 2 170

Br 3 out hip vertical 6 m.p.hr
E 2 172



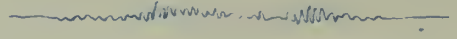
Br 2 out hip vertical 26 m.p.hr
E 4 155

Br 2 out hip vertical 23 m.p.hr
E 4 151

Br 2 out hip vertical 16 m.p.hr
E 4 149

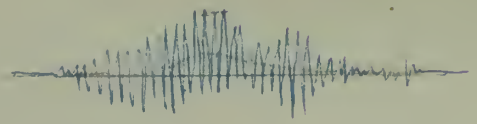
Br 3 out hip vertical 25 m.p.hr
E 2 173

Br 3 out hip vertical 23 m.p.hr.
E 2 171

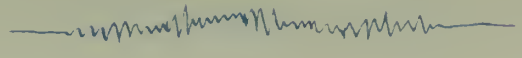


Br 3 out hip vertical 19 m.p.hr
E 2 175

Diagrams showing effect of automobile on hip vertical inside member Br 2 and 3 Br 2 plank floor Br 3 concrete floor

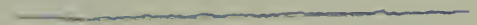


Br 2 inside hip vertical 12 m.p.h
E 7 154



Br 2 ins hip vertical 10 m.p.h
E 7 152

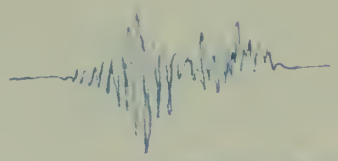
Br 2 ins. hip vertical 6 m.p.h
E 7 150



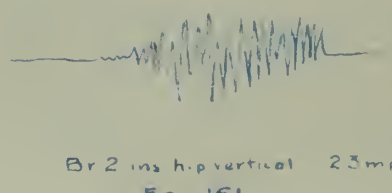
Br 3 ins hip vertical 15 m.p.h
E 8 174

Br 3 ins hip vertical 9 m.p.h.
E 8 170

Br 3 ins hip vertical 6 m.p.h.
E 8 172



Br 2 ins hip vertical 26 m.p.h
E 7 155



Br 2 ins hip vertical 23 m.p.h
E 7 151

Br 3 ins hip vertical 25 m.p.h
E 8 173

Br 3 ins. hip vertical 23 m.p.h
E 8 171

Bridge #1 Lower Chord L_2L_3 E_1 on inside E_3 on outside From Thesis 1909

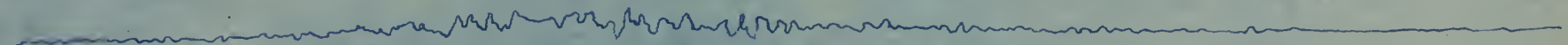
Load - Lumber Wagon

E_1 - 15 - Static

E_1 - 16 - 3.0 m.p.h. "W"

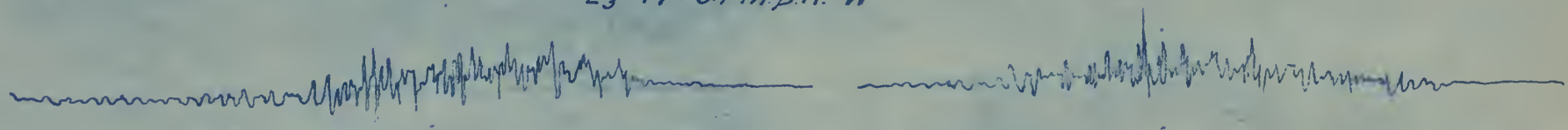
E_3 - 15 - Static

E_3 - 16 - 3.0 m.p.h. "W"



E_1 - 17 - 3.1 m.p.h. "W"

E_3 - 17 - 3.1 m.p.h. "W"



E_1 - 18 - 6.7 m.p.h. "T"

E_1 - 19 - 6.7 m.p.h. "T"

E_3 - 18 - 6.7 m.p.h. "T"

E_3 - 19 - 6.7 m.p.h. "T"

(Te)

Bridge 2 Inner Chord L_2L_3 E_2 on outside of west truss E_7 on outside of west truss

Load- Automobile

E_4 - 166 10 mph

E_7 - 166 - 10 mph

E_4 - 163 - 15 mph

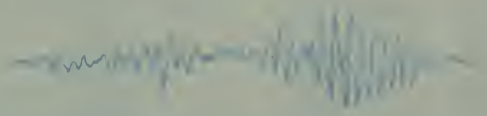
E_7 - 163 - 15 mph

E_4 - 169 - 27 mph

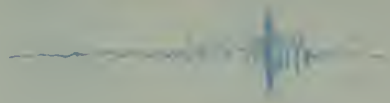
E_7 - 169 - 27 mph

E_4 - 164 - 7 mph

E_7 - 164 - 7 mph



E_4 - 168 - 12 mph

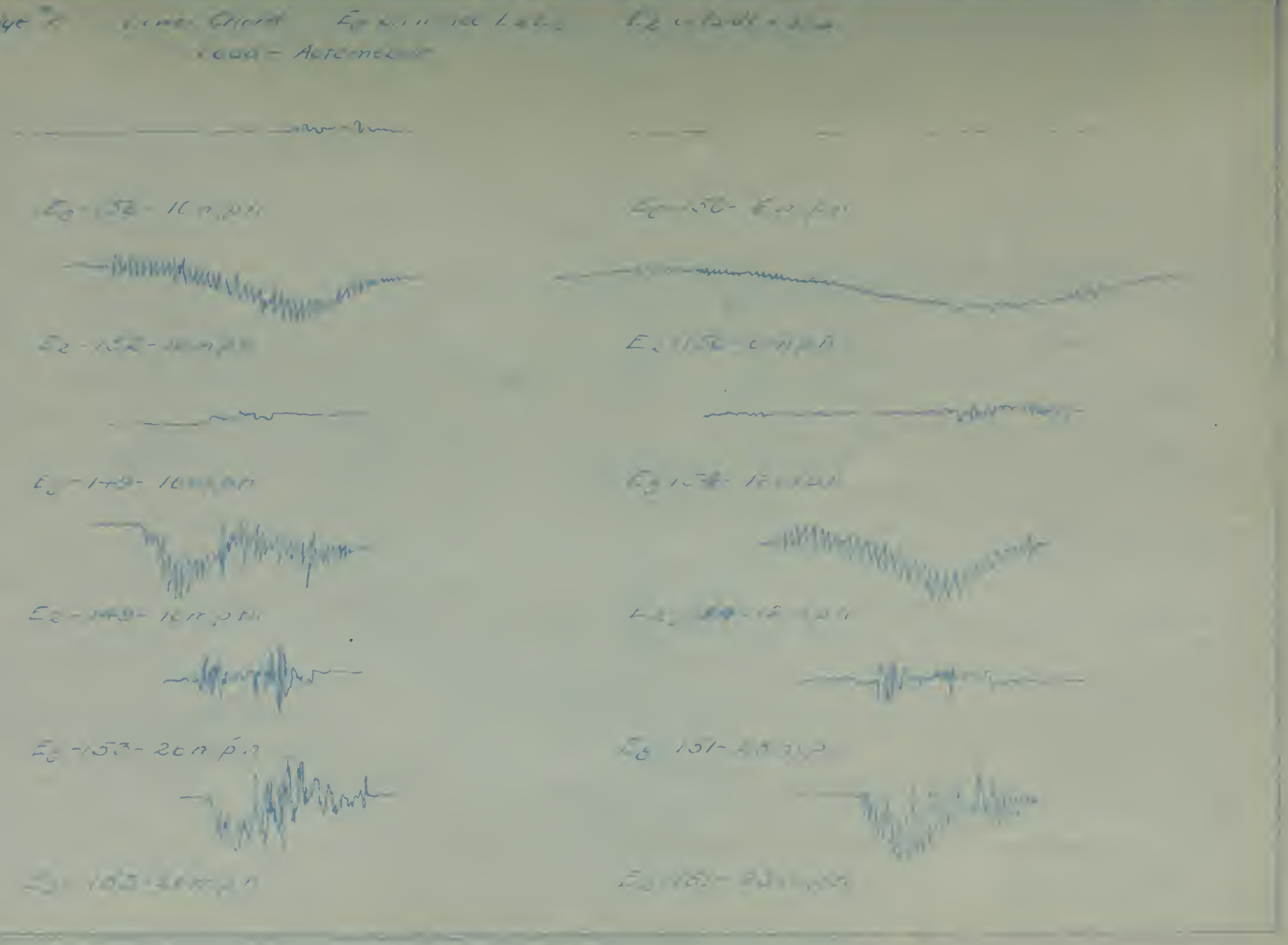


E_7 - 168 - 12 mph

E_4 - 167 - 25 mph

E_7 - 167 - 25 mph

(32)



Bridge 9 Watford Chord Lds E & inside EB outside Loaded Horse and 2 settlements

EA 199 37 mph W

EB 199 37 mph W

EA 201 72 mph T

EB 201 72 mph T

EA 203 181 mph G

EB 203 181 mph G

EA 195 36 mph W

EB 195 36 mph W

EA 200 71 mph T

EB 200 71 mph T

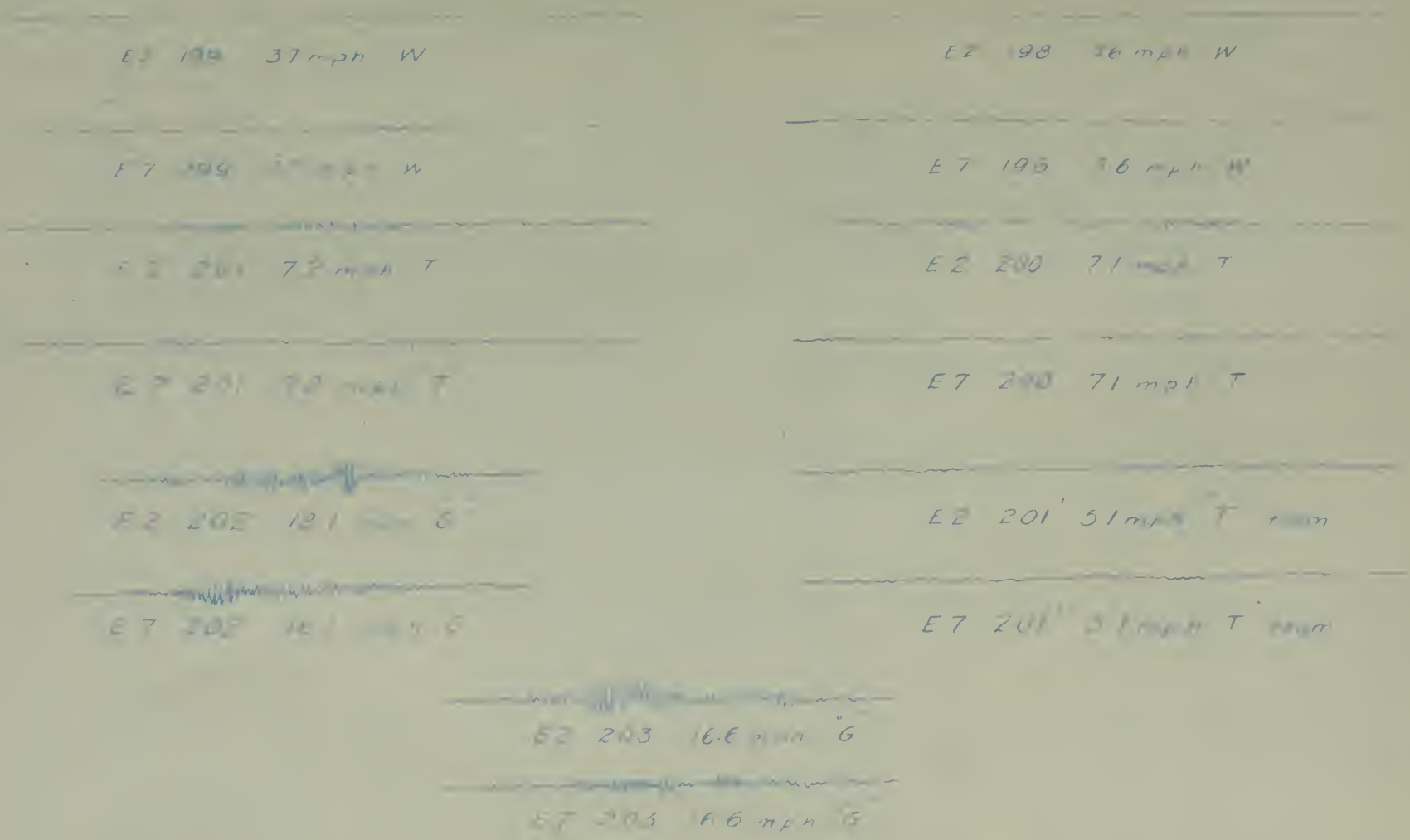
EA 201 34 mph T 100m

EB 201 34 mph T 100m

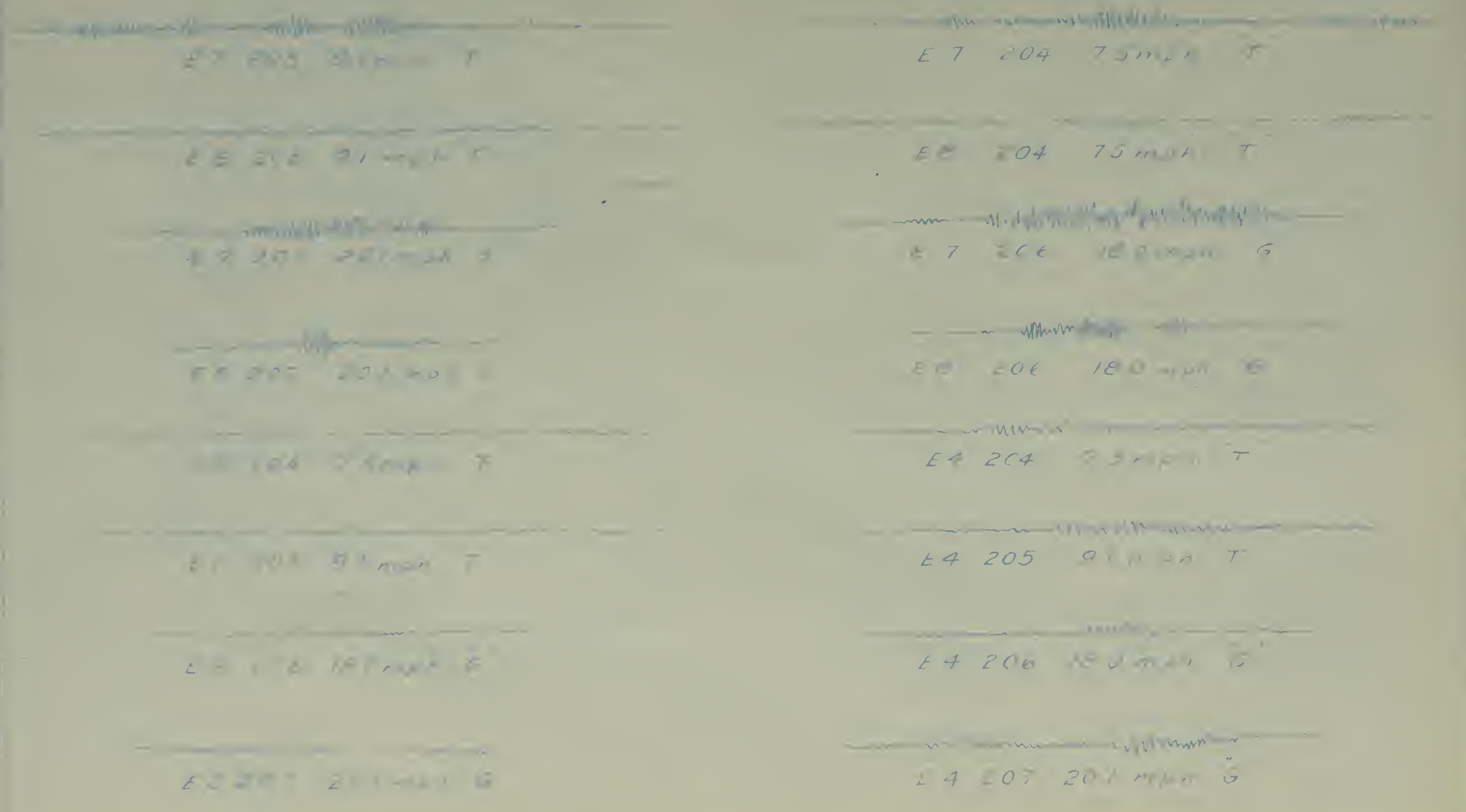
EA 203 182 mph G

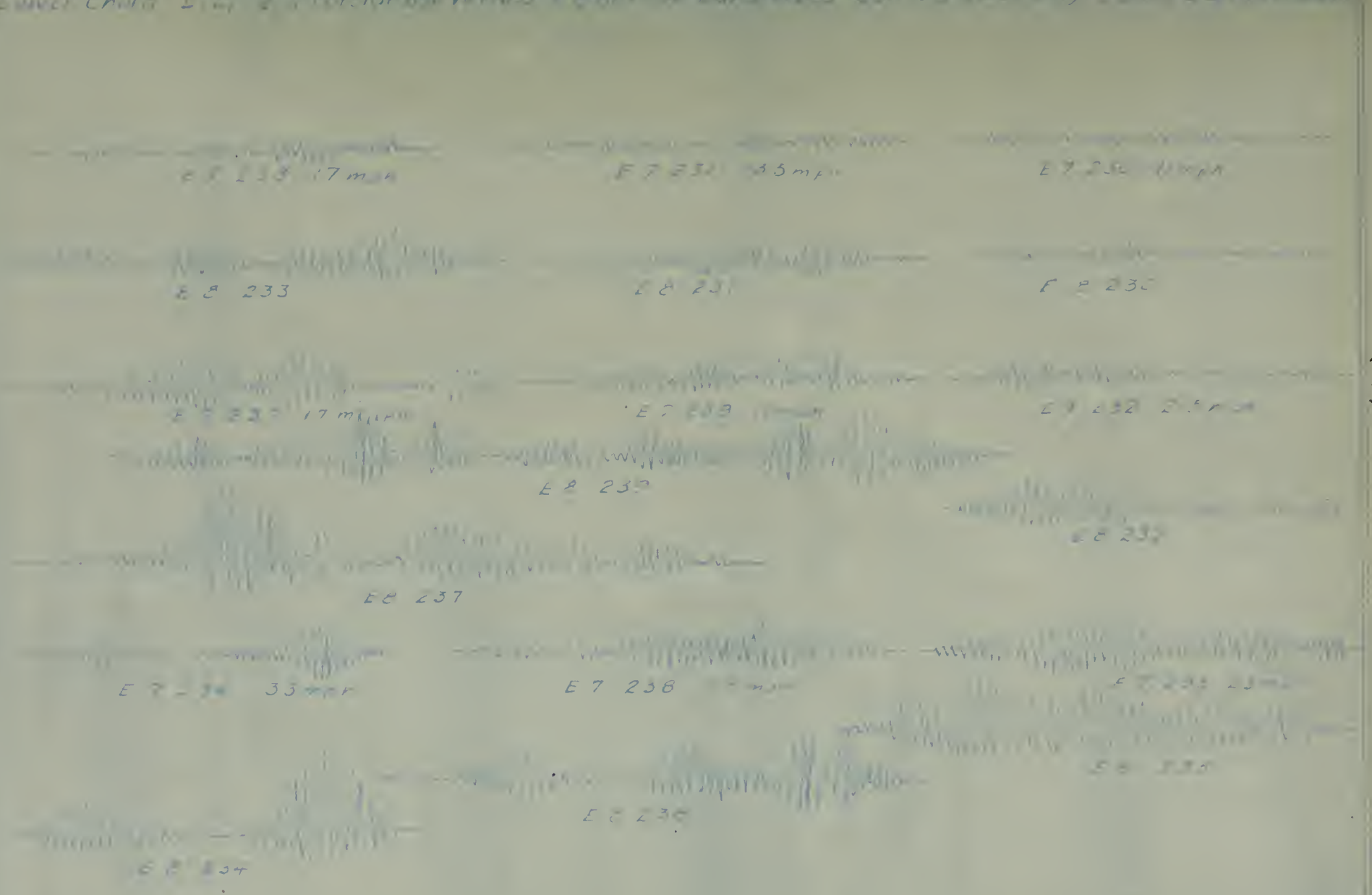
EB 203 182 mph G

Bridge 4 Bottom Chord E2 inside E2 outside Load - Horse and Coaster



Bridge #4 Bottom Chord E7 on outside L_1L_2 north truss E8 on outside L_1L_2 south truss
E2 on outside L_1L_2 south truss E4 on outside L_1L_2 south truss Lead Horse and Skeleton





Bridge #6 Span 144' Concrete Floor Load – Automobile
Lower Chord $L_1 L_2$ E1 on north truss E2 on south truss

E1-298 15 m.p.h.

E2-298 15 m.p.h.

E1-297 24.0 m.p.h.

E2-297 24.0 m.p.h.

E1-300 26 m.p.h.

E2-300 26.0 m.p.h.

E1-299 10 m.p.h

E2-299 10 m.p.h.

E1-296 20.0 m.p.h.

E2-296 20.0 m.p.h.

Bridge #6 Span 144' Concrete Floor Load: Horse and Rig
Bottom chords $L_1 L_2$ E2 on south Truss E7 on north Truss

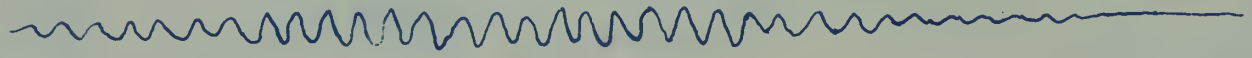
E2-291 10.5 m.p.h. "T"

E2-290 9.5 m.p.h. "T"

E7-291 10.5 m.p.h. "T"

E7-290 9.8 m.p.h. "T"

E2-295 10.5 m.p.h. "T"



E7-295 10.5 m.p.h. "T"

E2-294 20.0 m.p.h. "G"

E2-292 11.5 m.p.h. "T"

E2-293 11.0 m.p.h. "T"

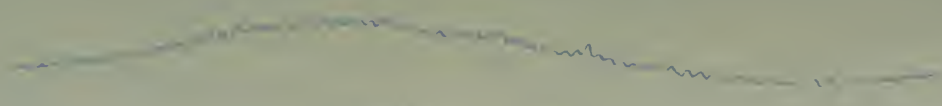
E7-294 20.0 m.p.h. "G"

E7-292 11.5 m.p.h. "T"

E7-293 11.0 m.p.h. "T"

Diagrams Showing effect of like speeds of Automobiles on like members of Br 3 (concrete floor) & Br 2 (plank floor)

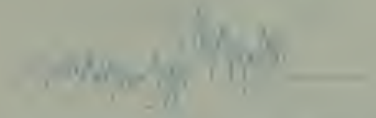
Br. 2 [illegible] L.L. 10 m.p.h.
E 2 [illegible]



Br. 2 out [illegible] L.L. 6 m.p.h.
E 2 [illegible]

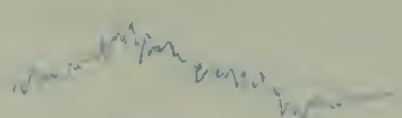
Br. 3 out chord L.L. 10 m.p.h.
E 2 180

Br. 3 out chord L.L. 5 m.p.h.
E 2 184



B2 outside chord L.L. [illegible] m.p.h.
E2 [illegible]

Br 2 outside chord L.L. 16 m.p.h.
E2 147



Br 2 outside chord L.L. 1[illegible] m.p.h.
E 2 [illegible] 54

Br [illegible] outside chord L.L. [illegible] m.p.h.
E [illegible] 83

Br 3 outside chord L.L. 1[illegible] m.p.h.
E 2 - 182

Br 2 outside chord L.L. [illegible] m.p.h.
E 2 [illegible] 150

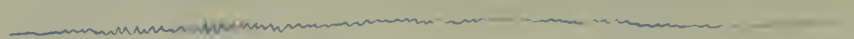
Br 2 outside chord L.L. [illegible] m.p.h.
E 2 [illegible] 190

Br 3 outside chord L.L. [illegible] m.p.h.
E 2 181

(29)

Bridge #1 Span 55' Diagonal U_1L_2 E2 on inside bar E8 on outside bar

Load - Horse, Light double seated rig & driver



E2 - 120 [illegible] "W"

[illegible] 3.8 [illegible] "W"

E8 - 120 4.2 [illegible] "W"

[illegible] 3.5 [illegible] W

E2 115 14.8 m.p.h "G" E2 [illegible] E2 - 116 [illegible] [illegible]

E8 - 115 14.8 m.p.h "G" E8 14 13.5 m.p.h G E8 - [illegible] 12 [illegible] E8 [illegible]

E2 18 17 m.p.h [illegible]

E [illegible] "G"

E8 - 118 7 m.p.h "G"

E8 [illegible]

(63)

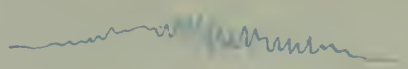
Automatic in Reverse

E2-105 10mph

E3-103 5mph

E3-102 5mph

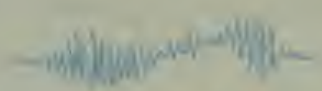
E4-105 10mph



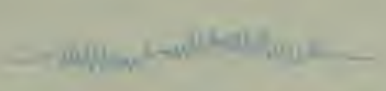
E4-105 5mph

E2-110-22mph

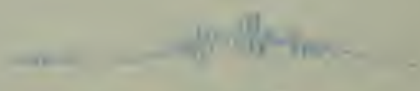
E2-109 20mph



E2-107 22mph



E2-106 15mph

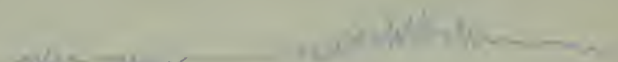


E2-104 (32mph)

E4-110-22mph

E4-108 20mph

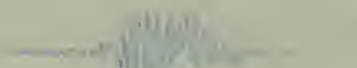
E4-107 20mph



E4-104 (25mph)

E2-112-0mph

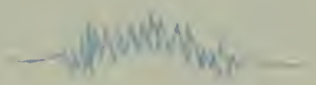
E2-111 27mph



E2-109 25mph

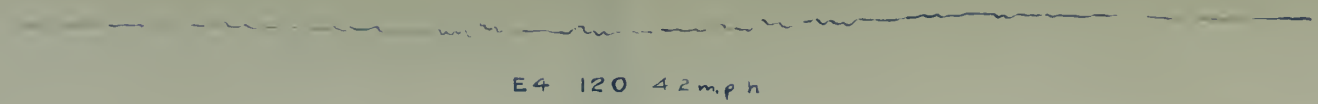
E4-112 0mph

E4-111 27mph



E4-109 25mph

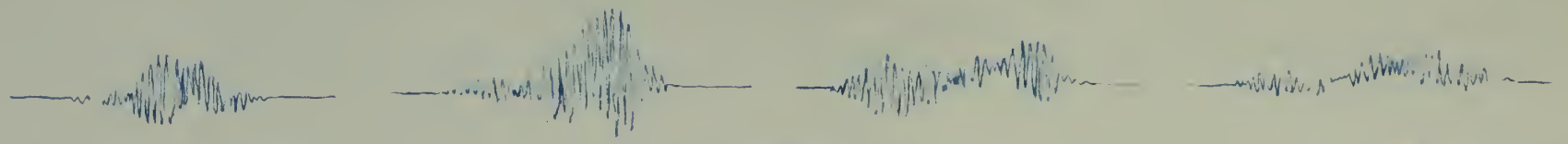
103-115 Extensometer on inside diagonal Automobile 103-112



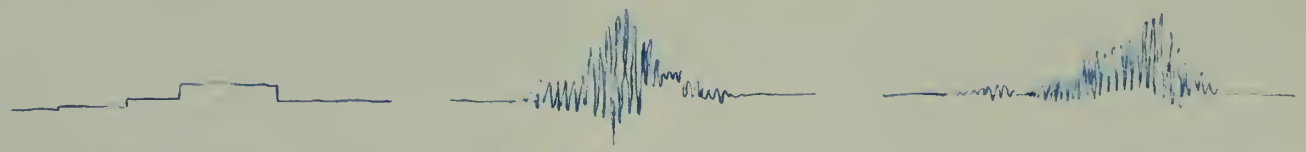
E4 120 42 m.p.h

E4 121 38 m.p.h.

E2 105 10 m.p.hr. E2 104 12.5 m.p.hr E2 103 5 m.p.hr



E2 109 25 m.p.hr. E2 108 20 m.p.hr. E2 107 20 m.p.hr. E2 106 15 m.p.hr



E2 112 0 m.p.hr E2 111 27 m.p.hr. E2 110 22 m.p.hr

E2 113 3 m.p.h.

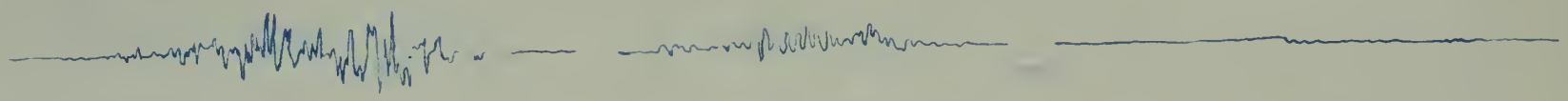
103-115 Extensometer on outside diagonal 116 121 on counter 103-112 [illegible] 112-121 Horse and buggy

E4 105 10 m.phr

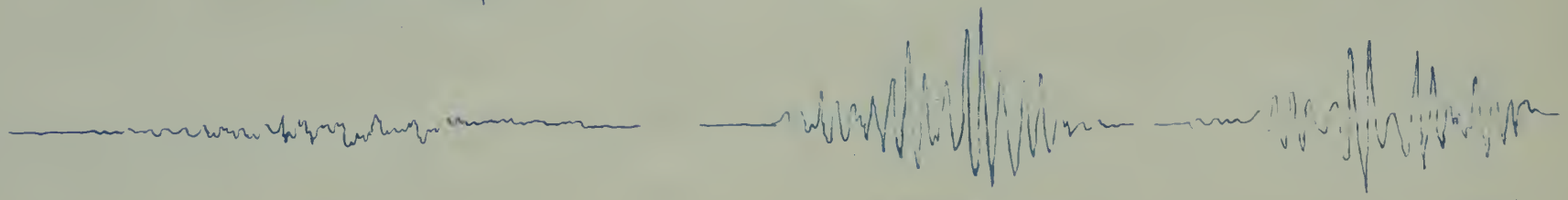
E4 104 125 m.phr E4 103 5 m.phr

E4 109 25 m.phr E4 108 20 m.phr E4 107 20 m.phr E4 106 15 m.phr

E4 114 135 m.p.h. E4 112 0 m.phr E4 111 27 m.phr E4 110 22 m.phr



E4 116 12 m.p.h. E4 115 14.8 m.p.h. E4 113 3 m.p.h.

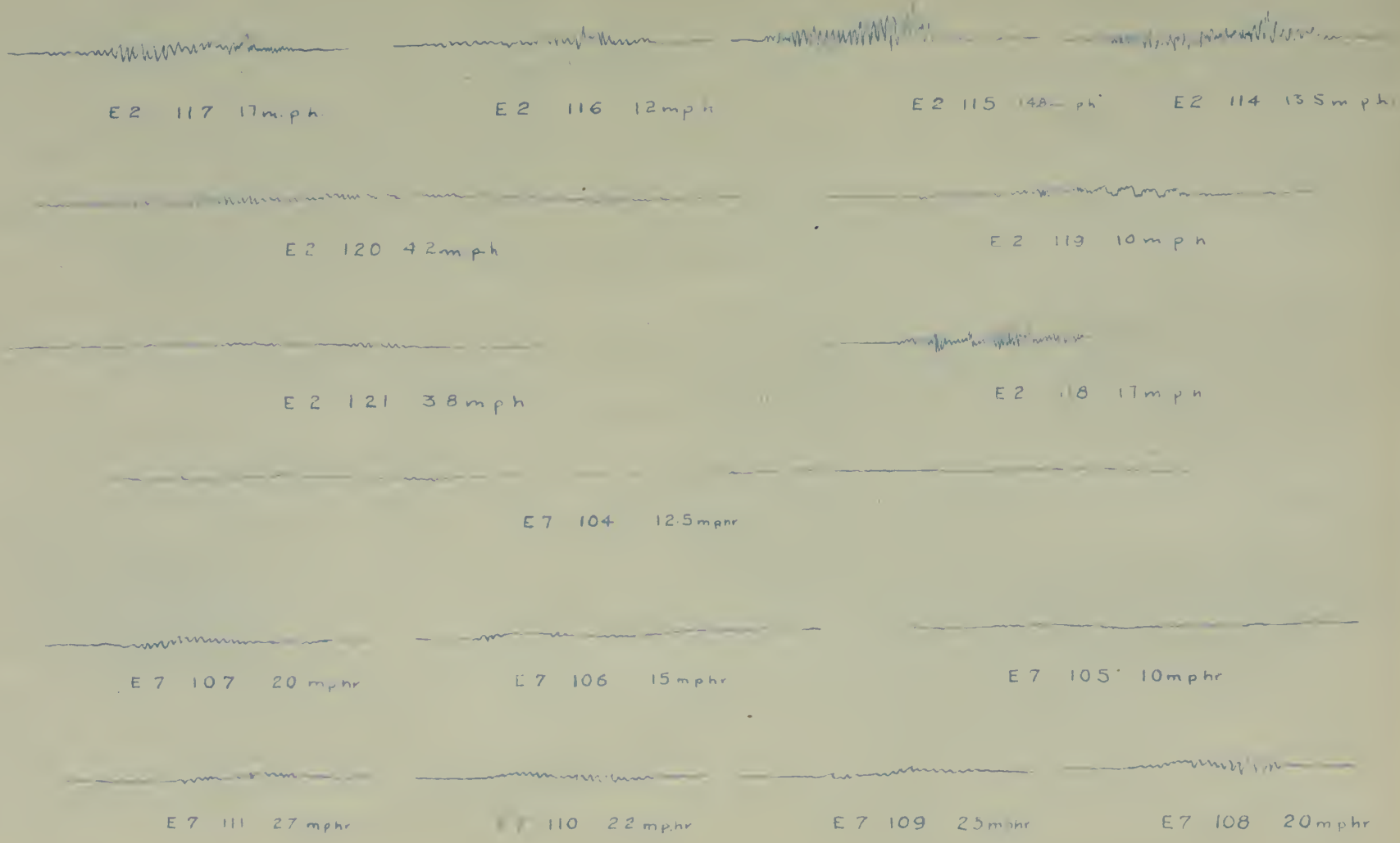


E4 119 10 m.p.h. [illegible] 17 m.p.h E4 117 17 m.p.h.

(66)

Extensometer on inside diagonal 113-121 Horse and buggy 114-121 104-111 Extensometer on outside flange hip vertical

104-111 Automobile



Bridge #3 Diagonal U. L2 E_4 on inside E_7 on outside

Load – Automobile

E_4 – 170 – 9 m.p.h.

E_7 – 170 – 9 m.p.h.

E_4 – 175 – 19 m.p.h.

E_7 – 175 – 19 m.p.h.

E_4 – 173 – 25 m.p.h.

E_7 – 173 – 25 m.p.h.

E_4 – 172 – 6 m.p.h.

E_7 – 172 – 6 m.p.h.

E_4 – 174 – 15 m.p.h.

E_7 – 174 – 15 m.p.h.

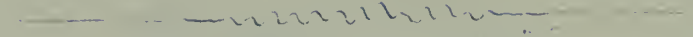
E_4 – 171 – 23 m.p.h.

E_7 – 171 – 23 m.p.h.

Bridge 3 Diagonal U_1L_2 E 4 on inside E 7 on outside Load Horse and 2 seated rig

E 4 124 10 m.p.h. "T"

E 7 124 10 m.p.h. "T"



E 4 128 14.7 m.p.h. "G"

E 7 128 14.7 m.p.h. "G"

E 4 127 18.0 m.p.h. "G"

E 7 127 18.0 m.p.h. "G"

E 4 123 3.6 m.p.h. "W"

E 7 123 3.6 m.p.h. "W"

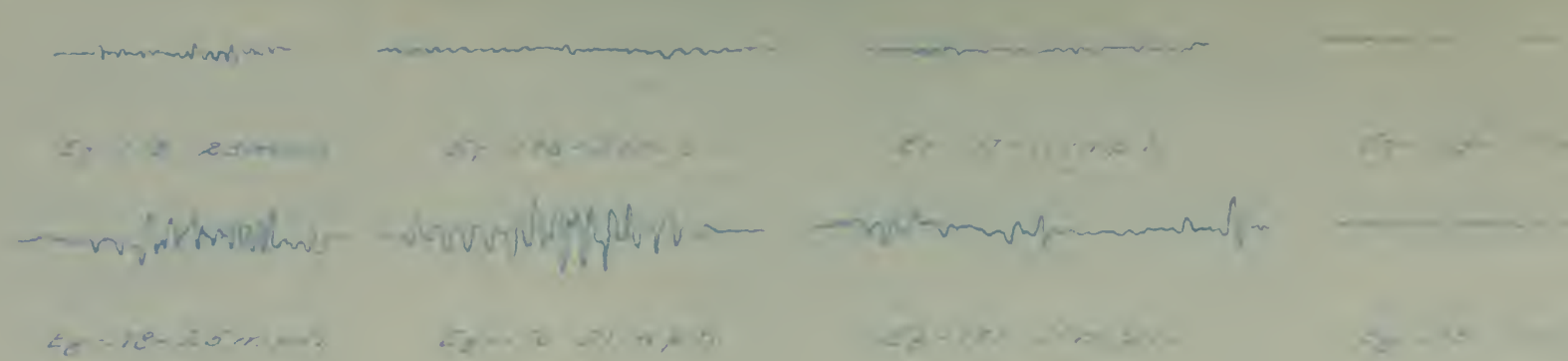
E 4 125 9.9 m.p.h. "T"

E 7 125 9.9 m.p.h. "T"

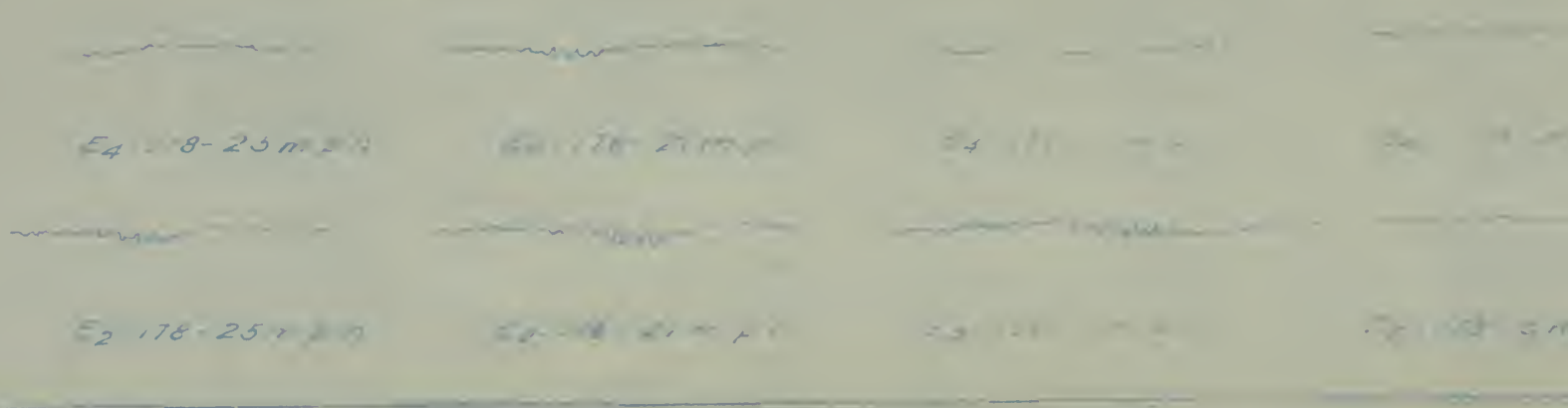
E 4 126 18.0 m.p.h. "G"

E 7 126 18.0 m.p.h. "G"

Bridge #3 Beyond $E_2 E_3$ - E_7 11.5 dc Eg
Load - Automobile



Bridge #3 Co
Load - Same



Briage #4 Span 105' - Diagonal U1L2 - E2 on inside E4 on outside
Load - Horse, light double seated rig and driver

E2-185 3.4 m.p.h "W"

E2-186 - 3.4 m.p.h "W"

E4-185 - 3.4 m.p.h "W"

E4-186 - 3.4 m.p.h "W"

E2-187 - 9.8 m.p.h "T"

E2-188 - 5.4 m.p.h. "T"

E4-187 - 9.8 m.p.h "T"

E4-188 - 5.4 m.p.h "T"

E2-189 - 16.1 m.p.h "G"

E2-190 - 12.0 m.p.h "G"

E4-189 - 16.1 m.p.h "G"

E4-190 - 12.0 m.p.h "G"

Bridge #4 Diagonal U_2L_3 E_1 on inside E_2 on outside

Load - Horse and light double seated rig.

E_1 - 191 - 3.4 m.p.h "V"

E_2 - 191 - 3.4 m.p.h "W"

E_1 - 193 - 6.2 m.p.h. "T"

E_2 - 193 - 6.2 m.p.h. "T"

E_1 - 195 - 16.0 m.p.h. "G"

E_2 - 195 - 16.0 m.p.h. "G"

E_1 - 192 - 3.4 m.p.h. "V"

E_2 - 192 - 3.4 m.p.h. "W"

E_1 - 194 - 7.5 m.p.h. "T"

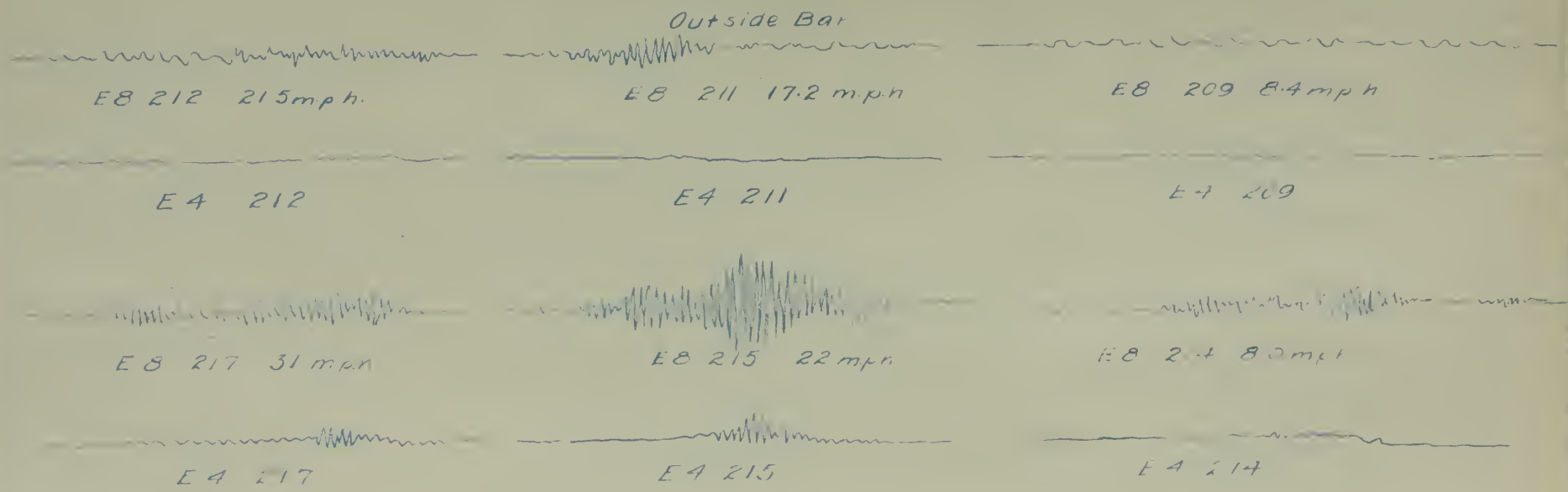
E_2 - 194 - 7.5 m.p.h "T"

E_1 - 196 - 20.5 m.p.h. "G"

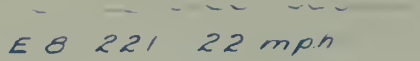
E_2 - 196 - 20.5 m.p.h "G"

(72)

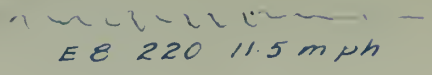
Diagonal U. L_2 Br 5 209-212 Horsesounding 214-217 Automobile



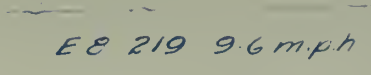
Diagonal U_1L_2 Br 5 East truss 219 222 Horse and rig 224 229 Automobile E8 outside bar E_4 inside



E 8 221 22 m.p.h



E 8 220 11.5 m.p.h

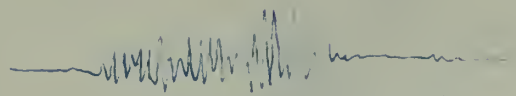


E 8 219 9.6 m.p.h

E 4 221

E 4 220

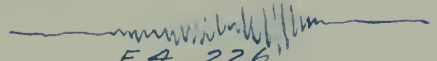
E 4 219



E 8 226 20 m.p.h

E 8 224 15 m.p.h

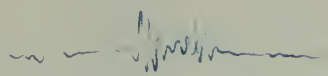
E 8 222 24 m.p.h



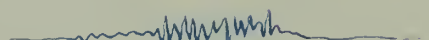
E 4 226

E 4 224

E 4 222

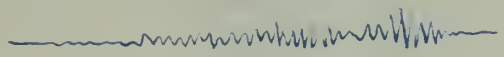


E 8 227 35 m.p.h



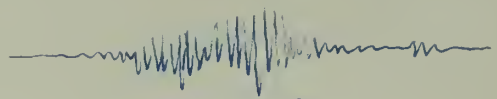
E 8 229 30 m.p.h

E 8 228 25 m.p.h



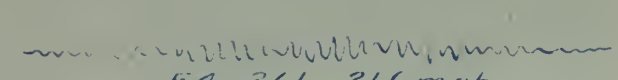
E 4 227

E 4 229

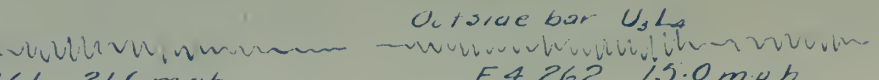


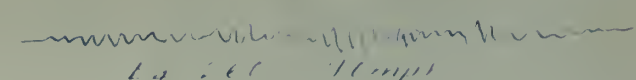
E 4 228

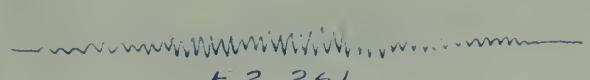
Diagonals U_3L_4 and U_5L_4 260-262 Horse & rig 264 268 Automobile B1 5


E4 261 21.6 m.p.h

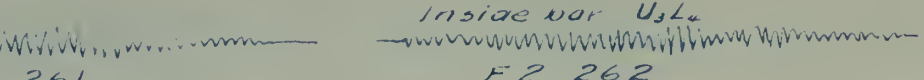
Outside bar U_3L_4

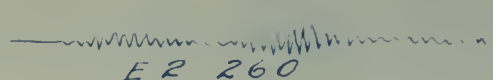

E4 262 15.0 m.p.h


E4 ·6· ·1 m.p.h

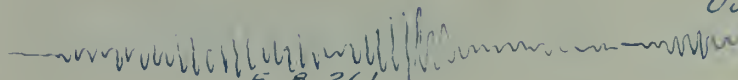

E2 261

Inside bar U_3L_4

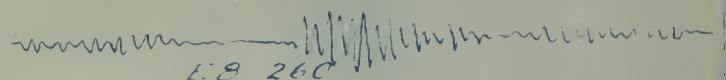

E2 262


E2 260

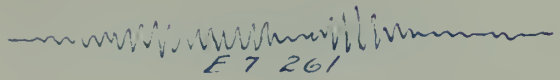
Outside bar U_3L_4


E8 261

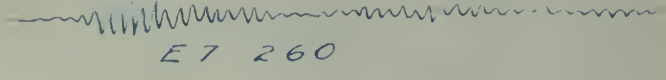
E8 262


E8 260

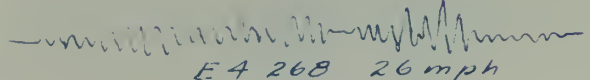
Inside bar U_3L_4


E7 261

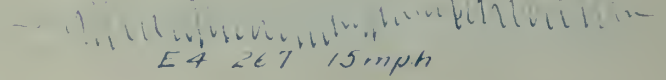
E7 262


E7 260

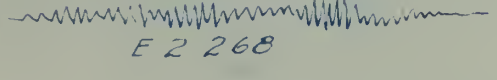
Outside bar U_3L_4

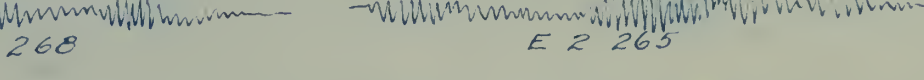

E4 268 26 m.p.h

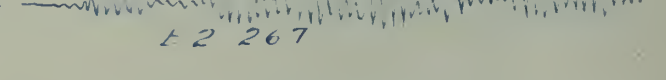
E4 265 22 m.p.h


E4 267 15 m.p.h

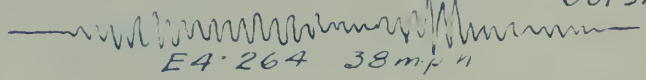
Inside bar U_3L_4

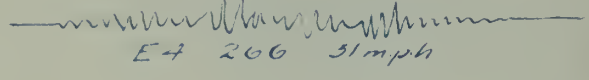

E2 268


E2 265

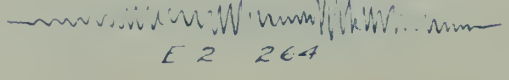

E2 267

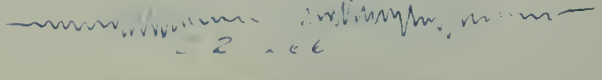
Outside bar U_3L_4


E4 264 38 m.p.h


E4 266 31 m.p.h

Inside bar U_3L_4


E2 264

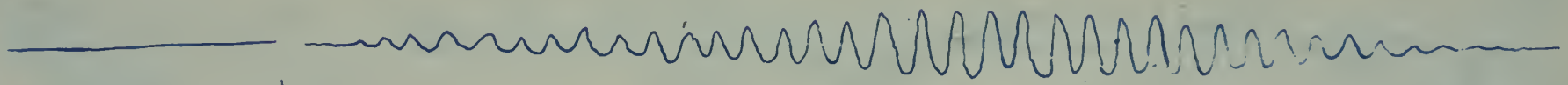

E2 266

Bridge #6 Span 144' Concrete Floor Load: Horse and Rig

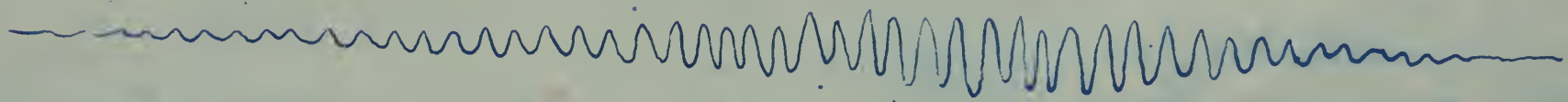
Diagonals U_1L_2 on North and South Trusses

E8 on south truss E4 on north truss

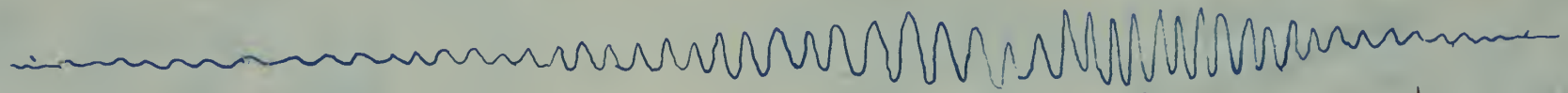
E8 291 10.5 m.p.h. "T" E8 290 9.8 m.p.h. "T"



E4-291 10.5 m.p.h. "T" E4-290 9.8 m.p.h. "T"



E8-295 10.5 m.p.h. "T"



E4 295 10.5 m.p.h. "T"

E8-294 20.0 m.p.h. "G" E8-292 11.5 m.p.h. "T" E8-293 11.0 m.p.h. "T"

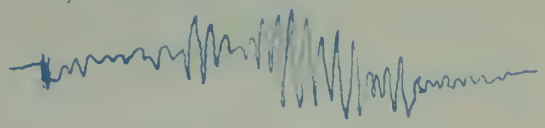
E4 294 20.0 m.p.h. "G" E4-292 11.5 m.p.h. "T" E4-293 11.0 m.p.h. "T"

(76)

Bridge #2 Counter L2L3 E7 on inside E4 on outside

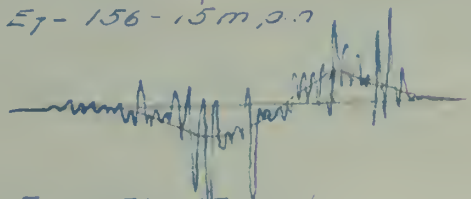
Load - Automobile

E7 - 159 - 10 m.p.h.

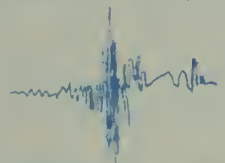


E4 - 159 - 10 m.p.h.

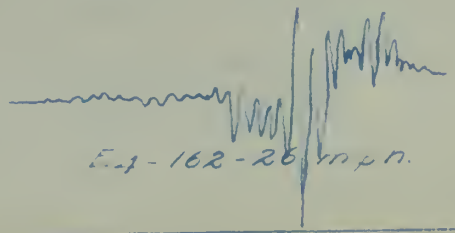
E7 - 156 - 15 m.p.h.



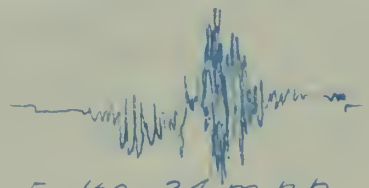
E4 - 156 - 15 m.p.h.



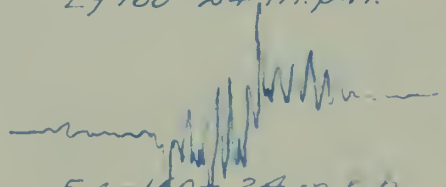
E7 - 162 - 26 m.p.h.



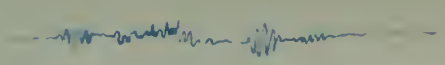
E4 - 162 - 26 m.p.h.



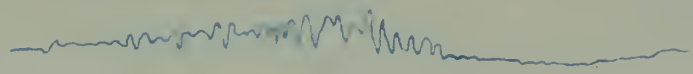
E7 - 160 - 24 m.p.h.



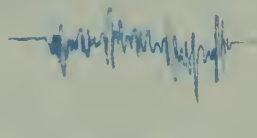
E4 - 160 - 24 m.p.h.



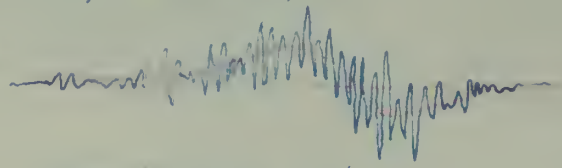
E7 - 157 - 6 m.p.h.



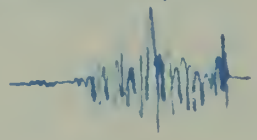
E4 - 157 - 6 m.p.h.



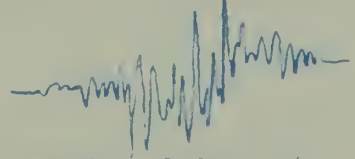
E7 - 161 - 13 m.p.h.



E4 - 161 - 13 m.p.h.



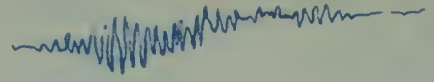
E7 - 158 - 24 m.p.h.



E4 - 158 - 24 m.p.h.

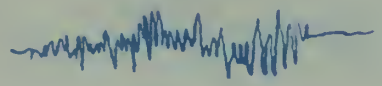
Bridge #2 Counter U_3L_2 E_2 on inside E_8 on outside

Load - Automobile



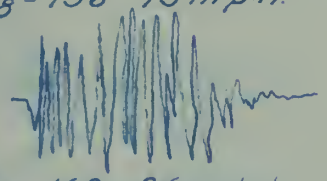
E_2 - 159 - 10 m.p.h.

E_8 - 159 - 10 m.p.h

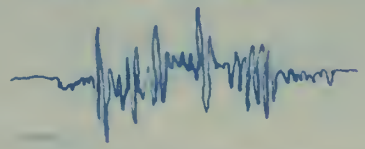


E_2 - 156 - 15 m.p.h.

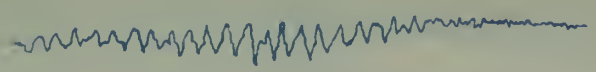
E_8 - 156 - 15 m.p.h.



E_2 - 162 - 26 m.p.h.



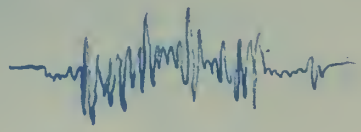
E_8 - 162 - 26 m.p.h.



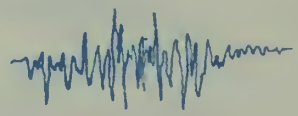
E_2 - 157 - 6 m.p.h.

E_8 - 157 - 6 m.p.h.

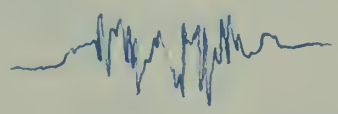
E_2 - 161 - 13 m.p.h.



E_8 - 161 - 13 m.p.h.



E_2 - 158 - 24 m.p.h.



E_8 - 158 - 24 m.p.h.

Bridge #3 Counters U_2L_3 E_4 inside E_2 outside
Load - "S" - Horse and double seated rig and D.H "S" + horse and one seated rig

E_4 - 143 - "D.H" - 15.3 m.p.h "G" E_4 - 142 - "D.H" - 11.2 m.p.h "T" E_4 - 141 - 17.0 m.p.h "G" E_4 - 140 - 9.1 m.p.h. "T"

E_2 - 143 - "D.H" - 15.3 m.p.h E_2 - 142 - "D.H" - 11.2 m.p.h. "T" E_2 - 141 - 17.0 m.p.h. "G" E_2 - 140 - 9.1 m.p.h "T"

Bridge #3 Lower Chord - L_2L_3 E_1 inside E_2 outside
Load - Same

E_1 - 147 - "D.H" - 17.0 m.p.h "G" E_1 - 146 - "D.H" - 10.7 m.p.h. "T" E_1 - 145 - 15.3 m.p.h "G" E_1 - 144 - 9.1 m.p.h. "T"

E_2 - 147 - "D.H" - 17.0 m.p.h "G" E_2 - 146 - "D.H" - 10.7 m.p.h. "T" E_2 - 145 - 15.3 m.p.h. "G" E_2 - 144 - 9.1 m.p.h "T"

Bridge #4 - Counter U3L2 - E8 on North truss E4 on South truss

Load - Horse and light double seated rig

E4 - 191 - 3.4 m.p.h. "W"

E8 - 191 - 3.4 m.p.h. "W"

E4 - 193 - 6.2 m.p.h. "T"

E8 - 193 - 6.2 m.p.h "T"

E4 - 195 - 16.0 m.p.h. "G"

E8 - 195 - 16.0 m.p.h. "G"

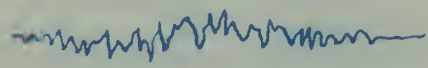
E4 - 192 - 3.4 m.p.h. "W"

E8 - 192 - 3.4 m.p.h. "W"

E4 - 194 - 7.5 m.p.h. "T"

E8 - 194 - 7.5 m.p.h. "T"

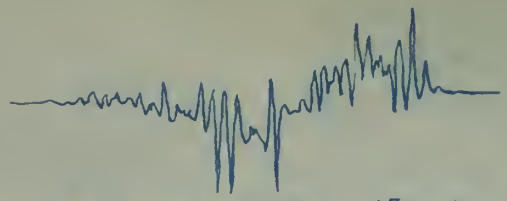
E4 - 196 - 20.5 m.p.h. "G"



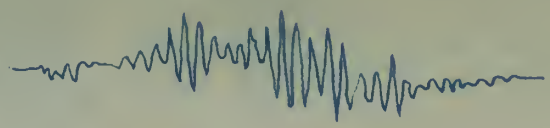
E4 - 196 - 20.5 m.p.h. "G"

(08)

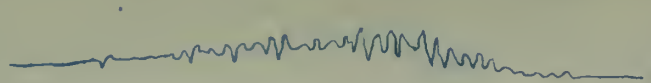
Diagrams showing effect of automobile on Br 2 and 3 Br 2 plank floor Br 3 concrete floor



Br 2 outside counter 15 m.p.hr.
E4-156



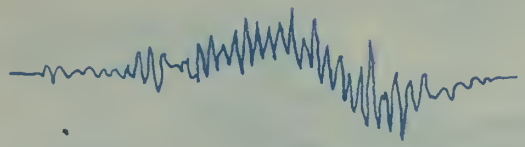
Br 2 outside counter 10 m.p.hr.
E4 159



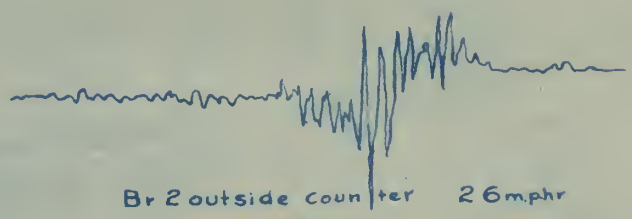
Br 2 outside counter 6 m.p.hr
E 4 157

Br 3 outside counter 10 m.p.hr
E 2 177

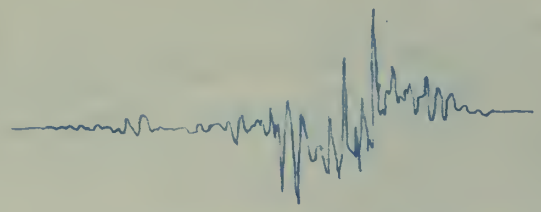
Br 3 outside counter 5 m.p.hr
E 2 179



Br 2 outside counter 13 m.p.hr.
E 4 161



Br 2 outside counter 26 m.p.hr
E 4 162

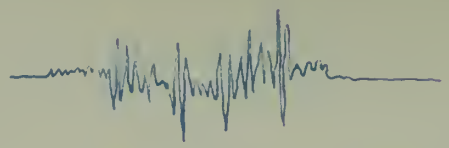


Br 2 outside counter 24 m.p.hr.
E 4 158

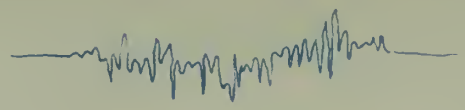
Br 3 outside counter 25 m.p.hr.
E 2 178

Br 3 outside counter 20 m.p.hr.
E 2 176

Diagrams showing effect of automobile on outside counter Br 2 and Br 3 Br 2 plank floor Br 3 concrete floor

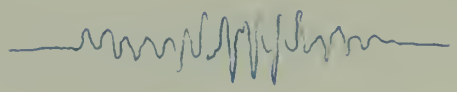


Br 2 out counter 13 mph
E 8-161



Br 2 out counter 10 mph
E 8-159

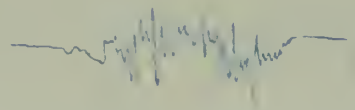
Br 2 out counter 6 mp.h
E 8-157



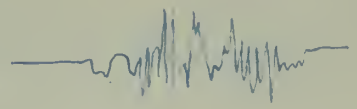
Br 3 out counter 21 mph
E 8 176

Br 3 out counter 11 mph
E 8-177

Br 3 out. counter 5 mp.h
E 8 179



Br 2 out counter 26 mph
E E 162



Br 2 out counter 24 mph
E 8 158

Br 3 out. counter 25 mph
E 8 178

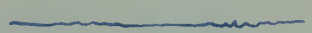
Bridge #1 Span 55' Upper Chord U_1U_2 Load:- Horse & Rig

E_1 on top inside flange. E_7 on bottom inside flange. E_3 on top outside flange. E_2 on bottom outside flange

E1-31 14.2m.p.h. "G"

E1-30 6.6m.p.h. "T"

E1-29 2.8m.p.h. "W"



E7-31 14.2m.p.h. "G"

E7-30 6.6 m.p.h. "T"

E7-29 2.8 m.p.h. "W"

E3-31 14.2m.p.h. "G"

E3-30 6.6 m.p.h. "T"

E3-29 2.8 m.p.h. "W"

E2-31 14.2m.p.h. "G"

E2-30 6.6 m.p.h. "T"

E2-29 2.8 m.p.h. "W"

Bridge #1 Span 55' Upper Chord $U_1 U_2$ Load: Team and Lumber Wagon

E1 on top inside flange. E7 on bottom inside flange. E3 on Top outside flange. E2 on bottom outside flange

E 1 - 23 6.6 m.p.h. "T"

E 1 - 20 3.3 m.p.h. "W"

E 7 - 23 6.6 m.p.h. "T"

E 7 - 20 3.3 m.p.h. "W"

E 3 - 23 6.6 m.p.h. "T"

E 3 - 20 3.3 m.p.h. "W"

E 2 - 23 6.6 m.p.h. "T"

E 2 - 20 3.3 m.p.h. "W"

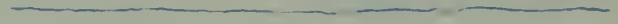
(84)

Bridge #1 Span 55' End Post L.U1 Load:- Horse and Rig

E2 on top inside flange. E7 on bottom inside flange. E3 on top outside flange. E1 on bottom outside flange

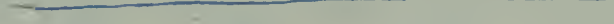
E2-34 17.1 m.p.h. "G"

E2-33 8.1 m.p.h. "T"



E2-32 3.7 m.p.h. "W"

E7-34 17.1 m.p.h. "G"

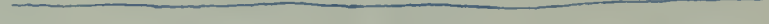


E7-33 8.1 m.p.h. "T"

E7-32 3.7 m.p.h. "W"

E3-34 17.1 m.p.h. "G"

E3-33 8.1 m.p.h. "T"



E3-32 3.7 m.p.h. "W"

E1-34 17.1 m.p.h. "G"

E1-33 8.1 m.p.h. "T"

E1-32 3.7 m.p.h. "W"

Bridge #2 Span 70' End Post L₀U₁ Loads:- Horse & Rig, 44-48; Team & Lumber Wagon 66-68

E1 on inside upper flange . E7 on outside upper flange

E1-48 13.6 m.p.h. "G" E1-46 9.8 m.p.h. "T" E1-44 2.9 m.p.h. "W"

E7 48 13.6 m.p.h. "G" E7-46 9.8 m.p.h. "T" E7-44 2.9 m.p.h. "W"

E1-68 17.0 m.p.h. "G" E1-67 8.5 m.p.h. "T" E1-66 3.4 m.p.h. "W"

E1-68 17.0 m.p.h. "G" E7-67 8.5 m.p.h. "T" E7-66 3.4 m.p.h. "W"

Bridge # 2 Int. Post. $U_2 L_2$ E_2 on South C E_8 on north C

Load - Automobile

E_2 - 166 - 10 m.p.h.

E_8 - 166 - 10 m.p.h

E_2 - 163 - 15 m.p.h

E_8 - 163 - 15 m.p.h

E_8 - 169 - 27 m.p.h

E_2 - 164 - 7 m.p.h.

E_8 - 164 - 7 m.p.h.

E_2 - 168 - 12 m.p.h.

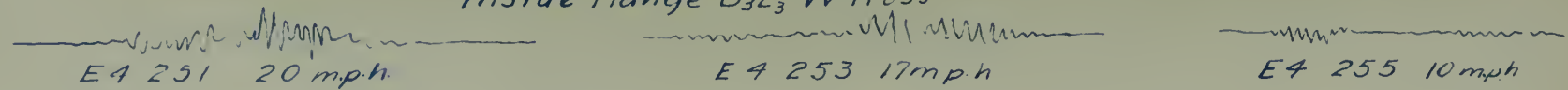
E_8 - 168 - 12 m.p.h.

E_2 - 167 - 25 m.p.h.

E_8 - 167 - 25 m.p.h.

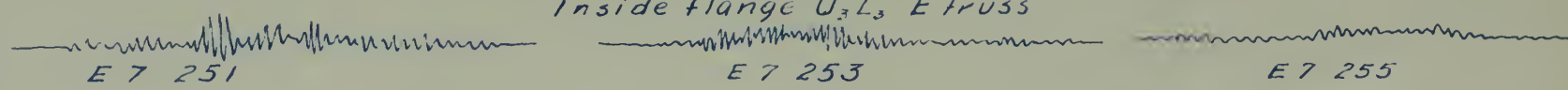
Intermediate Posts U_3L_3 and U_4L_4 on both trusses Automobile Br 5

Inside flange U_3L_3 W-truss



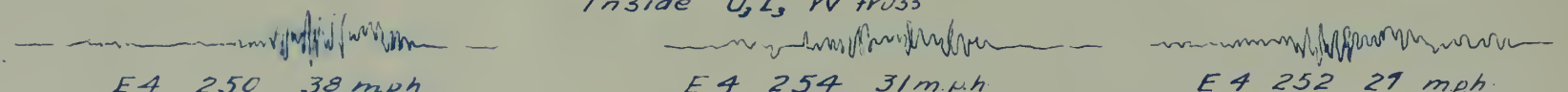
E4 251 20 m.p.h. E4 253 17 m.p.h. E4 255 10 m.p.h.

Inside flange U_3L_3 E truss



E7 251 E7 253 E7 255

Inside U_3L_3 W truss



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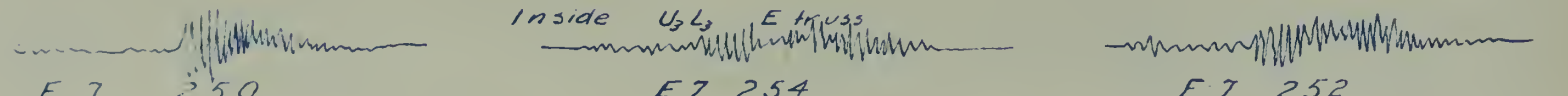
Inside U_3L_3 E truss



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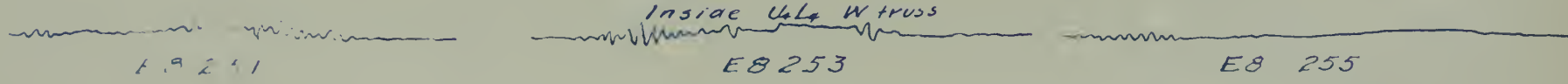
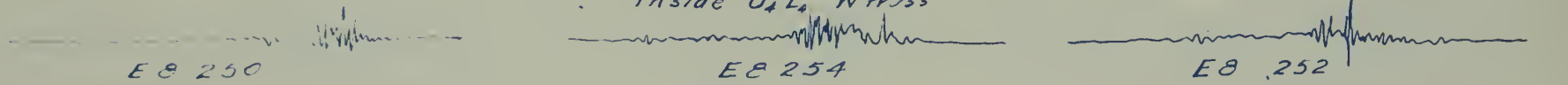
Inside U_4L_4 W truss



E9 251 E8 253 E8 255

Inside U_4L_4 W truss



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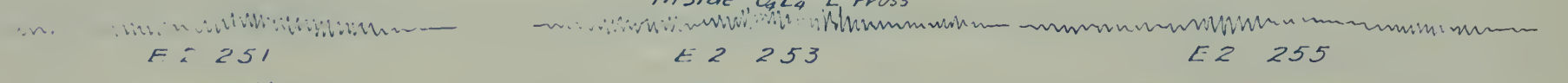
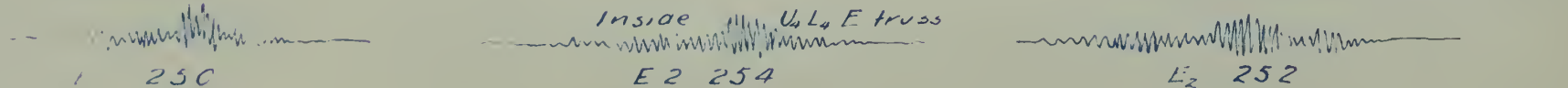


E2 251 E2 253 E2 255

Inside U_4L_4 E truss



1 250 E2 254 E2 252

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